Journal of the Society of Arts.

FRIDAY, FEBRUARY 23, 1866.

Announcements by the Council.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 28.—A Report by the Secretary on the results of the Art-Workmanship Competition, from its commencement, will be read, and a discussion taken upon it. The competitors and Art-workmen generally are invited to attend.

MARCH 7.—"On the late Anglo-French Exhibition, with a Proposal for the formation of an Anglo-French Association." By ROBERT CONINGSBY, Esq.

CANTOR LECTURES.

The concluding lecture of the course, on "Submarine Telegraphy," by FLEEMING JENKIN, Esq., F.R.S., will be delivered as follows:—

LECTURE V.—MONDAY, FEBRUARY 26.

ELECTRICAL TESTS.—(*Continued.*)

1. *Testing short lengths;* use of statical electricity Thomson's Electrometers.

2. *Testing joints.*—Bright and Clark's test by accumulation; testing from outside with battery; test from outside by electrometer.

3. *Induction tests.*—(*a.*) Meaning of "charge," "capacity," and "inductive capacity." (*b.*) Object of diminishing the capacity of a cable. (*c.*) Methods of measuring the capacity of a cable. (*d.*) Capacity per knot of various cables. (*e.*) Specific inductive capacity of various materials; effects of temperature and pressure.

4. *Tests to detect faults.*—(*a.*) Fault of continuity with copper, bare or insulated. (*b.*) Defective insulation.

5. *Tests to determine the position of faults.*—(*a.*) Insulated fault of continuity. (*b.*) Dead earth. (*c.*) Partial loss of insulation in a cable with one conductor; resistance of fault; polarization; earth currents. (*d.*) Partial loss of insulation in a cable with two or more conductors.

The lectures commence each evening at Eight o'clock.

NATIONAL PORTRAIT EXHIBITION, 1866.

Season Tickets for this Exhibition are now ready, and may be had at the Society of Arts, on application to the Financial Officer, price £1.

PARIS UNIVERSAL EXHIBITION OF 1867.

Forms of application for space, and copies of the regulations, may be had on application to the Secretary of the Society of Arts, and should be applied for immediately.

Although the 28th February, 1866, has been fixed as the last day for receiving demands for space, intending Exhibitors are requested not to delay forwarding such demands, but to send them as soon as possible.

Proceedings of the Society.

CANTOR LECTURES.

"ON SUBMARINE TELEGRAPHY." BY FLEEMING JENKIN, ESQ., C.E., F.R.S.

LECTURE IV. MONDAY, FEBRUARY 19.

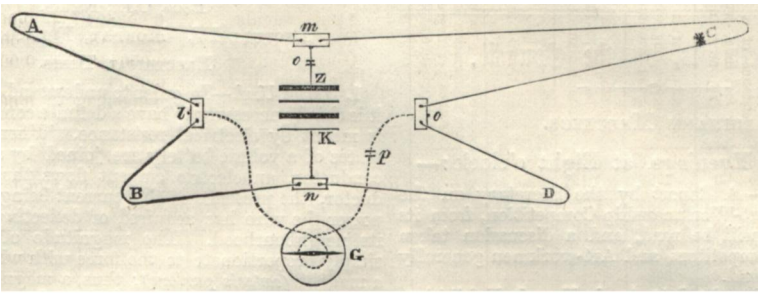
ELECTRICAL TESTS.

1. *Terms Used.*—In order to understand electrical tests, it is chiefly necessary to have a definite conception of what is meant by electrical resistance. When the two end plates of a voltaic battery are joined by a wire or other conductor, an electric current flows through the conductor, the presence of the current being shown by the power the wire has acquired of deflecting a magnet in its neighbourhood. The magnitude of a current is simply proportionate to the force with which it acts on a magnet *(cæteris paribus):* thus, a magnet hung inside a coil of insulated wire, is called a galvanometer, or current measurer, since it may be said to measure the current by the deflection of the magnet. When this deflection is small, as was the case with the instruments exhibited, in which the deflection of the magnet was indicated by the motion of a reflected ray of light, the deviations of that ray of light from its normal position may be considered as true relative measurements of the current producing that deviation. The battery may be looked upon as a constant source of power, and the conductor as a kind of pipe conveying the current of electricity. The magnitude of the current depends, with a given battery, on what is called the resistance of the circuit. If the wire be small and long, the current will be feeble, and the resistance of the circuit is said to be great. If the wire be short and thick, the resistance will be small. The resistance of a conductor is the property in virtue of which it prevents a given battery from producing more than a given current, precisely as the resistance of a pipe to the passage of water might be defined as the property in virtue of which it prevents the passage of more than a certain current of water with a given head. The resistance of conductors varies, not only with the dimensions but with the materials of which the conductor is composed; and this resistance can be measured, *i.e.*, compared with the resistance of any other given wire, in virtue of Ohm's law, viz., that the current through a given circuit is inversely proportional to the resistance, and directly proportional to the force producing it. That force is constant with a given battery, so that if we find our current halved by the introduction of a certain wire into a circuit, we may be sure that the resistance of the circuit is doubled; but in making that calculation we must take into account the resistance, not only of the wire, but of the measuring instrument and of the battery; when this is done the old distinctions of quantity and intensity currents will be found unnecessary, and indeed false, since a current has but one mensurable property, viz., its magnitude or strength. A current existing in a circuit which already includes a considerable resistance is what used to be called an "intensity current;" a current in a circuit which includes no considerable resistance is what used to be called a "quantity current." The first is little affected by the addition of a resistance which may almost wholly annihilate the second. A convenient method of measuring the resistance of a battery, due to Professor Thomson, is given in Appendix II. By the simple application of Ohm's law we might compare the resistances of two wires by observing the relative effect which they produce in a given circuit; but this is inconvenient, and hardly admits of much accuracy. The battery may vary, both as to force and resistance, during the two tests, and even if constant, the accuracy of the observation will be limited by the accuracy with which a deflection can be observed. More accurate practical

tests have, therefore, been invented to measure and compare the resistance of conductors.

Tests of Conductor.—Every test used is a test of resistance, and all depend on Ohm's law above cited; the instruments may be much varied, but the most convenient is probably that known as "Wheatstone's balance, or differential measurer." Let four wires be joined with a galvanometer and battery, as in Fig. 1; then, if A, B, C, and D represent the resistances of the four wires, no current whatever will

FIG. 1.



pass through the most sensitive galvanometer when $\frac{A}{B} = \frac{C}{D}$, but if the ratio $\frac{A}{B}$ be a little larger than $\frac{C}{D}$ a current will pass through the galvanometer in one direction; if $\frac{A}{B}$ be smaller than $\frac{C}{D}$, the current will be in the opposite direction. An explanation of this fact will be given in the ensuing Lecture. Four wires thus arranged allow us to measure the resistance of any one of them which is not known, in terms of the three others: if A and B are equal, we may try how great a length of D is exactly equal in resistance to C, a selected standard, and this is precisely the test adopted to choose copper of small resistance or good conducting power. C is, say, 100 inches of copper wire, known to be good. Then the observer tries how great a length of copper wire from a new hank must be inserted at D to bring the galvanometer to zero, or no deflection. If this length be 105 inches the new hank is five per cent. better in quality than the standard; if the length be 95 inches, then the new hank is five per cent. worse in quality than the standard. But this is not all: if we desire to measure a coil of wire having ten times the resistance of C, we may make B exactly ten times A, and then when we have adjusted the length of the wire D, so that the galvanometer is at zero, we may be sure that the resistance of D is ten times C. Hitherto we have spoken of comparing two random wires, but it will clearly be convenient to have some common term of comparison, such as the foot for length, or the pound for weight. With this view the resistance of a certain piece of wire is chosen as the unit, and when other wires are measured, instead of being always directly compared, they are each compared with the unit, and are said to have each so many units of resistance. Several units have been proposed; the lecturer uses that known as the British Association unit, sometimes called the "Ohm." When a unit has been chosen, whether for length, weight, or electrical resistance, it will always be found convenient to have multiples of the unit for measuring large quantities, and fractions of the unit for comparison with small quantities. With this object separate pieces of wire, equal to 1, 2, 3,....to 1,000, or even 10,000 units, are prepared in cases, and conveniently arranged so that any resistance required can be selected and inserted in the required circuit. These cases of graduated wires are called sets of resistance coils, and are variously arranged by the different makers. Mr. C. W. Siemens and Messrs. Elliott, Brothers, both make sets of British Association coils. If, when possessed of such a set of coils, we receive a wire of which we do not know the resistance, we may arrange a Wheatstone's balance in which two equal coils are connected as at A and B; the new wire at D and the set of coils at C. We then find by trial the number of units required to bring the galvanometer to zero. If we find D too small to be conveniently measured thus, we may choose two coils equal to 1 and 100 for B and A. When the galvanometer is at rest on completing the circuit the resistance of D will be the hundredth part of the coils included at C. Similarly, if D be large we may make the coil A 1, and B 100; then the resistance of D will be 100 times that of the coils required at C to bring the galvanometer to zero. A still greater degree of precision in comparing C and D will be obtained if part of the wire between A and B be a uniform wire laid along a measured scale, and if the point *l*, to which the galvanometer wire is attached, be made moveable along this wire, the resistance of which must be known as compared with the other parts of A and B. Now, if A, B, C, and D are as nearly balanced as they can be by the addition and subtraction of units at C, a still more perfect balance (indicated by the absence of deflection in the galvanometer) may be obtained by shifting *l* a little; then, if its position be observed, giving the exact ratio between A and B the exact value of D can be found in terms of the unit used at C by a simple rule of three sum. In fact, every change that the rule of three is susceptible of, can be worked out effectually by the above arrangement, and measurements can be made without an error of one part in 100,000. Experiments were shown illustrating the above statements. It will now be seen that we have the means of comparing the resistance of wires very accurately, and of comparing all wires with a common unit; but it is also convenient to be able to calculate beforehand what the resistance of a given wire will be or ought to be, and for this purpose it will be sufficient to know the resistance of some one wire of known dimensions of each material; the resistance of all other wires of that material can then be simply calculated, since that resistance is directly proportional to the length, and inversely proportional to the section, of the wire. Table IX. is a table of "specific resistances," defined in various ways. The first column contains the numbers which will probably be found most useful. The following is an example of its use:—let it be required to know the resistance at 0° of a conductor of pure hard copper, weighing 400lbs. per knot. This is equivalent to 460 grains per foot. The resistance of a wire weighing one grain per foot is 0·2106; therefore the resistance of a foot of a wire weighing 460 grains will be $\frac{0{\cdot}2106}{460}$, but the resistance of one knot will be 6,087 times that of one foot, hence the resistance required will be $\frac{6087 \times 0{\cdot}2106}{460} = 2{\cdot}79$ units. If

TABLE IX.

Specific resistance in B.A. units of metals and alloys at O° Centigrade, from Dr. Matthiessen's experiments.

Name of Metals.	Resistance of a wire one foot long, weighing one grain.	Resistance of a wire one metre long, weighing one gramme.	Resistance of a wire one foot long, 1-1000th inch in diameter.	Resistance of a wire one metre long, one millimetre in diameter.	Approximate per centage of variation in resistance per degree of temperature at 20°
Silver annealed	0·2214	0·1544	9·936	0·01937	0·377
„ hard drawn.....	0·2421	0·1689	9·151	0·02103	...
Copper annealed	0·2064	0·1440	9·718	0·02057	0·388
„ hard drawn ...	0·2106	0·1469	9·940	0·02104	...
Gold annealed	0·5849	0·4080	12·52	0·02650	0·365
„ hard drawn	0·5950	0·4150	12·74	0·02697	...
Aluminium annealed	0·06822	0·05759	17·72	0·03751	...
Zinc pressed	0·5710	0 3983	32·22	0·07244	0·365
Platinum annealed ...	3·536	2·464	55·09	0·1166	...
Iron annealed	1·2425	0·7522	59·10	0·1251	...
Nickel annealed.....	1·0785	0·8666	75·78	0·1604	...
Tin pressed	1·317	0·9184	80·36	0·1701	0·365
Lead pressed	3·236	2·257	119·39	0·2527	0·387
Antimony pressed.....	3·324	2·3295	216·0	0·4571	0·389
Bismuth pressed	5·054	3·525	798·0	1·689	0·354
Mercury liquid	18·740	13·071	600·0	1·270	0·072
*Platinum Silver, alloy hard or annealed	4·243	2·959	148·35	0·3140	0·031
†GermanSilver, hard or annealed	2·652	1·850	127·32	0·2695	0·044
‡Gold Silver alloy, hard or annealed	2·391	1·668	66·10	0·1399	0·065

the diameter of the wire be given instead of its weight per knot, the calculation is still simpler, and the constant for English measures would be taken from the third column of the table. Thus the resistance at 0° of a knot of pure hard-drawn copper wire 0·1 in. diameter would be $\frac{6087 \times 9{\cdot}94}{100^2} = 6{\cdot}05$. It will be seen that annealing wires materially alters their resistance, though it leaves their chemical composition quite unaltered. A rise in temperature increases the resistance of all the metals, and Dr. Matthiessen discovered that for all pure metals the increase of resistance between 0° and 100° C is sensibly the same except for iron. Table X. gives the formula and constants by which the resistance of any wire between those limits may be calculated. Roughly, all pure metals increase from 0·37 to 0·39 per cent. for each degree of temperature within the limits usually occurring in rooms. Table XI. gives the specific resistance of the more important metals at various temperatures. The resistance of most alloys is very much greater than the mean of the metals composing them; indeed, a singularly small mixture of a foreign metal reduces the resistance of the pure metals very largely; so much so, that in commerce copper cannot be obtained which is equal or even nearly equal to that of pure copper. The figures and constants given in the above tables are only applicable with accuracy to pure metals. In old cables the quality sometimes was very bad, but lately the resistance of cable copper has usually been only about 10 per cent. more than that of pure copper. Table XII. gives the resistance of the copper of various cables at 24° centigrade, also the specific resistance at the same temperature. Although alloys cannot be used for cables, owing to their high resistance, they are very useful in the construction of resistance coils, since not only are coils of great resistance made of small bulk by their use, but these coils are much less altered by a change of temperature than if made of simple metals. The tables contain the resistances of the chief alloys now in use with the co-efficients for temperature

* The alloy used for B.A. resistance units, 2 parts platinum, 1 part silver by weight.
† The alloy commonly used for resistance coils.
‡ 2 parts gold, 1 part silver by weight.

TABLE X.

Constants, for metals or alloys, by which to calculate the resistance R at temperature t from the resistance r at zero :—$R = r(1 + a t \pm b t^2)$.

	a.		b.
*Pure metals.....	0·003824	+	0·00000126
Mercury.....	0·0007485	−	0·000000398
German silver	0·0004433	+	0·000000152
Platinum silver....	0·00031	..	..
Gold silver	0·0006999	−	0·000000062

TABLE XI.

Resistance in B A units of wires one foot long weighing one grain.

Temperature Centigrade.	Soft copper.	Hard copper.	German silver.†	Platinum silver.‡
0	0·2064	0·2106	10·61	16·97
5	0·2102	0·2147	10·628	17·00
10	0·2144	0·2188	10·647	17·02
11	0·2153	0·2197	..	..
12	0·2161	0·2205	..	..
13	0·2170	0·2214	..	..
14	0·2178	0·2222	..	..
15	0·2186	0·2231	10·665	17·05
16	0·2194	0·2239	..	..
17	0·2203	0·2248	..	..
18	0·2211	0·2256	..	..
19	0·2220	0·2265	..	..
20	0·2228	0·2272	10·682	17·08
21	0·2237	0·2283	..	..
22	0·2242	0·2288	..	..
23	0·2253	0·2299	..	..
24	0·2262	0·2308	..	..
25	0·2271	0·2317	10·702	17·10
26	0·2279	0·2325	..	..
27	0·2287	0·2334	..	..
28	0·2296	0·2343	..	..
29	0·2305	0·2352	..	..
30	0·2313	0·2360	10·720	17·13
31	0·2322	0·2369	..	..
32	0·2328	0·2375	..	..
33	0·2340	0·2388	..	..
34	0·2348	0·2396	..	..
35	0·2357	0·2405	10·739	17·15
36	0·2365	0·2413	..	..
37	0·2376	0·2424	..	..
38	0·2383	0·2432	..	..
39	0·2391	0·2440	..	..
40	0·2400	0·2449	10·757	17·18

TABLE XII.

Resistance per knot and specific resistance in B A units of conductors and insulators of various cables at 24° C.

Name of Cable.	Resistance per knot of conductor at 24° C.	Specific resistance of foot grain at 24° C.	Resistance per knot of insulator at 24° C after one minute's electrification.	Specific resistance of insulator, or resistance of one foot cube, at 24° C, after one minute's electrification.
Red Sea	7·94	·2700	28×10^6 to 38×10^6	$0{\cdot}875 \times 10^{12}$ to $1{\cdot}187 \times 10^{12}$
Malta-Alexandria, mean	3·49	·2637	115×10^6	4.06×10^{12}
Persian Gulf, mean	6·284	·2469	193 „ 10^6	$5{\cdot}910$ „ 10^{12}
2nd Atlantic, mean....	4·272	·2421	349 „ 10^6	$11{\cdot}22$ „ 10^{12}
Hooper's Persian Gulf core, mean.....	...	...	8000 „ 10^6	245 „ 10^{12}

* Approximate or mean formula.
† Calculated from spec. gravity 8·47.
‡ Calculated from spec. gravity 12·0. (Approximate values only.)

corrections. There are many points of great practical importance in measuring the resistance of conductors, which cannot be here fully treated of. Thus all resistance coils should be wound double so that the current may pass both ways round the coil equally; this prevents self-induction—a disturbing element. Care must generally be taken in using the Wheatstone balance to connect first the battery at *o* (fig. 1), and then the galvanometer at *p*. The battery must be left connected for the shortest possible time, to avoid heating the wires; special precautions must be taken to avoid resistances at connexions, which are often considerable. The resistance of the wires composing the balance should not differ too greatly from that to be measured; short wire galvanometers answer best for short wires; long wire galvanometers for long wires; one cell of large surface generally gives better results than large batteries; the temperature of the wire to be measured, and that of the resistance coils should be accurately observed. These and many other points could only be fully developed in a treatise on testing. Practically, the copper of a cable is tested before it is used, to ascertain whether its quality is equal to that specified; when a knot of wire is covered it is again tested for resistance, to ensure that the proper quantity and quality of wire has been used; finally, after the cable is covered the resistance test serves to check the length of the cable in circuit, to ensure that the conductor is at no point interrupted, and that the temperature in the tank is not higher than it should be.

3. *Tests of Insulator.*—A material is said to insulate well if it offers great resistance to the passage of a current of electricity. The word resistance is here used precisely in the sense in which it was applied to conductors; conductors and insulators both resist the passage of a current, the former allowing a considerable current to be produced by a small battery, the latter allowing but a feeble current to be produced by a powerful battery. The object of surrounding a conductor with a good insulator is to prevent any serious proportion of the current from being diverted to the sea or earth near the conductor; the insulator acts the part of the pipe directing and containing the current; the copper acts more nearly the part of the vacant space, allowing the current to pass, and retarding it only by friction. A pipe to contain water can be made so that it shall not leak, but no material known, except dry air, will perfectly contain electricity; some leakage, indicated by a current, always occurs; and the simplest test of the soundness of the insulator is to connect one end of the conductor A (Fig. 2.) with one pole of a battery, Z, the other

FIG. 2.

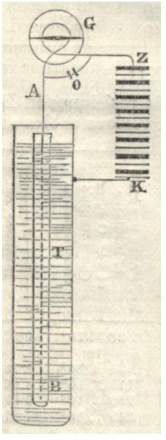
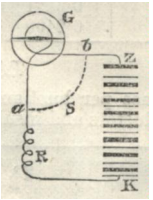


FIG. 3.



pole of which is joined to the water surrounding the insulated wire in the tank T (Fig. 2). If a galvanometer, G, be placed between the battery and the conductor, and the other end of the conductor insulated, any current producing a deflection in the galvanometer must pass through the sheath from the copper to the water; such a current is often called a leakage. With a battery of known strength, and a galvanometer with which the observer is already well acquainted, the greater or less deflection of the galvanometer needle will often be sufficient to show whether this leakage is so excessive as to indicate a flaw in the insulator connecting the water and the copper; this was the earliest insulation test; but it is clearly far from giving a measurement of the accurate kind which has been described for conductors. No two galvanometers are alike, nor is any one instrument constant in its indications; moreover an instrument of suitable delicacy for one length of insulated wire is unsuitable for another; the test is, therefore, a very rude and imperfect one, but a slight modification allows us to use it for the purpose of expressing with some accuracy the resistance of the insulator in the same units as those used for the conductor. Immediately after observing the deflection with the connections in Fig. 2, remove the insulated wire A B, and join the galvanometer and battery, as in Fig. 3, inserting a set of resistance coils at R, and joining *a b* by a short coil S, with a resistance bearing a certain definite ratio to that of the galvanometer, for instance, with $\frac{1}{999}$ th part of that resistance. The current from the battery will, at *a* and *b*, divide itself between the two branches S and G, in the ratio of 999 to 1; now adjust the resistance coils R until the same deflection be obtained as before; then, if we call x the whole resistance of the circuit when connected as in Fig. 3, the resistance of the circuit in Fig. 2, which is sensibly equal to that of the insulating sheath, will be 1000 x, since the current in the first case must have been 1000 times less than in the second case, when only $\frac{1}{1000}$th part of the current flowed through the galvanometer. It will be obvious that we might use for the first connection a battery of 100 times greater electromotive force than is used in the second case; then the resistance of the insulator would be 100,000 x. In many cases x may be taken as equal to R, neglecting the other parts of the circuit. This can always be safely done if R be large, S very small, and KZ be a large single cell; but it is not difficult to calculate the whole resistance x, when the above conditions cannot be obtained. The resistance between *a* and *b* is made up of two wires joined in what is called multiple arc; call S the one resistance, G the other, then the resistance of the two is $\frac{1}{\frac{1}{G}+\frac{1}{S}}$ To obtain the total resistance of the circuit, add the resistance of the battery and the resistance R. It will be further obvious that the resistance R need not be adjusted so as to give exactly the deflection obtained with the connexion in Fig. 2. If any convenient deflection be observed with a given resistance R_1, the resistance R is given by a simple proportion. Moreover, it is unnecessary to repeat the test of Fig. 3 every time an insulation test is made; we may often assume that unless some accident has happened to the instrument it will remain constant for some hours; in that case, having found the resistance which corresponds to one deflection (Fig. 2), the resistance corresponding to other deflections results from a simple proportion. It is assumed, of course, that a galvanometer is used in which the deflections are proportional to the magnitude of the current, as is the case with reflecting galvanometers. In making the test (Fig. 2) care must be taken to prevent the first shock of the current from passing through the galvanometer; for this purpose a connection of very small resistance may be placed, as at at *o*. This connection must be broken immediately after the battery has been applied. The reason why this precaution is necessary will be mentioned in the next lecture. An astatic reflecting galvanometer, with coils round both magnets, of the form designed by Professor Thomson, and with long fine wire, will be found well adapted for this

test; to ensure accuracy care must be taken to make the coil S, frequently called a shunt, of thick wire and of such form as not easily to be heated; to maintain this strand as nearly at the same temperature as the galvanometer coil as may be; to let the battery remain in circuit as short a time as possible; to let the insulated coil remain in the water for such a time as may ensure its being at a known temperature throughout; to practice extreme cleanliness in the keys used; to cut the ends of the wires tested to avoid loss by surface conduction. When these and other precautions have been taken, tolerably uniform results can be obtained, but they do not approach in accuracy those obtained in measuring conductors. For instance, the accuracy cannot be greater than that with which a deflection can be observed, or say one part in 200. In long cables the resistance across the insulator can be measured with the Wheatstone balance, by using the insulator as one of the four conductors A B C or D (Fig. 1). It will be seen that as the length of an insulated wire increases, the resistance to conduction across the insulator decreases, for there is continually a larger and larger area of material to conduct the current, and the distance across the insulator from the copper to the water remains the same. Thus the insulating sheath of 1,000 miles of Malta-Alexandria cable is nearly equal in conducting power (or resistance) to a sheet of gutta-percha one acre in area and one-tenth of an inch in thickness, separating a copper plate from a sheet of water. The resistance at 24° C of this insulating sheet of enormous section and very small thickness would be about 115,000 BA units; the resistance at 24° C of the long copper conductor would be about 3,490 BA units. These resistances are not so dissimilar as to be incomparable even directly by the Wheatstone balance; resistance coils of German silver of 10,000 units, or even 100,000 units, nearly equal to the above insulation resistance, as it is sometimes called, are not uncommon. It will now be seen how it is that bodies of which the specific properties differ so enormously as copper and gutta-percha, can yet be directly compared. The specific resistance of insulators can be given just as the specific resistance of conductors has been given, but it is customary to use a different definition, and call the specific resistance of an insulator the resistance of a foot cube electrified on the two opposite faces. Table XII. gives the resistance of the gutta-percha of the most important cables per knot, and their specific resistance as above defined. The following equation allows the resistance R of a core of known dimensions to be calculated from its specific resistance S:—

$$(5.)\quad R = S \frac{\log_{\epsilon} \frac{D}{d}}{2 \pi L}$$

here $\log_{\epsilon} \frac{D}{d}$ = the hyperbolic log. of the ratio of the diameter of the insulator to that of the conductor (given in Table III. above); $\pi = 3{\cdot}1416$, and L = the length of the core in feet. To convert the specific resistance, as above defined, into that of a wire or rod one foot long, weighing one grain, the figures given in the table for gutta percha must be multiplied by about 443,000. The fashion observed of writing 10^{12}, or ten at the power twelve, simply means that the number given must be multiplied by 1,000,000,000,000, or by one followed by twelve zeros. This plan of writing large numbers saves space, and is convenient in multiplication for those acquainted with the simpler properties of exponents. Hitherto that quality only has been spoken of in which insulators resemble conductors, viz., that of possessing a mensurable resistance; but there are marked differences in the behaviour of an insulator and a conductor when a current is passing through them. The resistance of the conductor, if prevented from heating, remains perfectly constant; but the resistance of an insulator is apparently much greater during the second minute after the battery is applied than during the first; it increases again, but not so much, during the third minute, and continues to increase by smaller and smaller amounts for at least half-an-hour. It will be shown in the final lecture that this apparent change of resistance is probably due to a kind of absorption; but, whatever be the cause of the phenomenon, it entails great inconvenience in testing. When the current is reversed, the apparent resistance falls as low as ever, or lower, and then again increases for half-an-hour. To meet this continual change, due to what is called electrification, tests are always made at definite times, generally one minute after the battery has been applied; but even with this precaution the residual effects of previous electrification are often embarrassing. All insulating substances, except air, present the same phenomenon, but in a greater or less degree. It is very marked, frequently producing a change of 50 per cent. in the apparent resistance of gutta-percha, and its effect is greater in cables which are thickly covered with the insulator. Neither pressure nor change of temperature greatly affect the proportionate effect of electrification. With Mr. Hooper's material, as supplied to the Indian Government, the change produced is extraordinary; at the end of ten minutes the resistance seemed to have increased nearly fourfold, and at the end of about 19 hours the resistance was 23 times greater than at the end of one minute.* This singular property of insulators is one of the chief difficulties to be met in any attempt to obtain strictly accurate measurements. A change of temperature also causes a much greater alteration in insulators than in conductors; and a rise of temperature causes a fall in resistance instead of an increase; thus the specific resistance of gutta-percha is about 20 times as great at freezing point as at 24° centigrade. Gutta-percha, as now supplied, behaves very uniformly in this respect, as is shown by the independent experiments of Mr. Siemens, Messrs. Bright and Clark, and the lecturer. The following equation, due to Messrs. Bright and Clark, will allow the resistance R of any core at a temperature T + t (in degrees centigrade) to be calculated from the resistance r at T° centigrade.

$$(6.)\quad R = r \times 0{\cdot}8878^{t}.$$

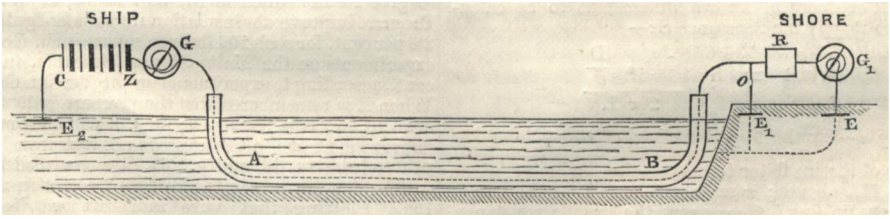
The number 0·8878 is not quite constant, but seems to vary between that figure and 0·9. The effect of temperature on india rubber is not nearly so great, but the lecturer is not in possession of experiments, the whole circumstances of which, including the preparation of the india rubber, are known to him, and he prefers not to give results which might be misapplied and mislead. Pressure improves the insulation resistance of gutta-percha 2·3 per cent. for each 100 lbs. per square inch, according to experiments on the Malta-Alexandria cable, and 2·6 per cent., according to experiments on the Persian Gulf cable. When it is remembered that the pressure in 2000 fathoms is about two tons per square inch, it will be seen that the improvement due to this cause is not to despised. India-rubber behaves differently. Mr. Siemens published some curious experiments in the British Association report for 1863, showing that pure india-rubber slightly fell off in resistance as the pressure increased. No sensible effect on the resistance of gutta-percha has yet been observed, due to the absorption of water. The object of the tests described is first to ensure the use of a proper material, the quality of which may be specified in the contract; secondly, to detect any serious flaw in the outer coating, which would at once be shown by the diminution it would cause in the resistance. The more accurately the resistance of the insulator can be observed and calculated, the more certain we can feel of detecting even the smallest irregularity.

4. *Tests at Sea.*—Whereas tests on land are, in great measure, directed to secure a fit quality of material, the tests at sea should have but one object—the detection of a fault as soon as it occurs, and the determination of its nature and position. Common forms of galvanometer cannot be used at sea, but Professor Thomson's well-known marine galvanometer allows every test hitherto described

* This information was kindly supplied by Mr. Laws.

to be applied as rigorously at sea as on shore. It consists of a very light magnet and mirror, strung on a fine tight fibre, and so perfectly balanced as not to deflect from its normal position relatively to the suspending frame and coils, however they may be inclined in any direction. A powerful magnet, in a fixed position relatively to the suspending frame and coils, directs the suspended magnet, and overcomes the influence of the earth, from which the magnet is still further screened by a thick hollow iron case, which wholly surrounds the coils, except where a glass window allows a ray of light from a lamp to enter and return so as to fall upon a scale after reflection from the mirror. These instruments are made by Mr. White, of Glasgow, and Messrs. Elliott, Brothers, of London, and are now almost exclusively used for tests at sea, which may so far be considered as quite unaffected by the direction of the ship or its motion. Two disturbing agencies are found in the currents induced in the coils of cable as the ship rolls, and the so-called earth currents, depending on the different electric potential or tension of the earth, which may occur between the earth plate on shore, and the connexion with the sea at the ship. These disturbances are readily overcome by the use of sufficiently strong batteries, so that no details or explanation of their action need be given here. It may be granted that on board ship all tests can be accurately made, and it only remains to consider what system shall be followed to ensure immediate detection of a rupture in the copper conductor or an injury to the insulator. Hitherto it has been a common practice to arrange a succession of tests recurring in a constant order at definite intervals of time. During the first 20 minutes of each hour an insulation test may be used; and the simple test (Fig. 2.) of watching that the spot of light in the galvanometer does not quit its proper place on the scale, as it certainly will do the instant any flaw in the insulator allows a connexion between the copper and the water, is probably the best as well as the simplest. During the next 20 minutes the resistance of the copper may be measured, showing that it is unbroken, and indicating the temperature of the bottom. During the last 20 minutes speaking instruments may be connected with the cable, and intelligence given and received; then *da capo*. But this system has great defects. We may wish to send or receive intelligence when it is impossible to do so; the clerk, or clock, or shore may not keep time with the ship, and cause needless alarm or confusion; special emergencies may require special tests, and then the routine plan either prevents these, or causes confusion; but worse, much worse than all this, a fatal injury to the insulation may altogether escape detection during the periods allotted for continuity tests and speaking; it may pass over into the sea, and, when finally discovered, may be some miles from the ship. It would be better to maintain constantly a simple insulation test, and let the shore end remain insulated and unwatched. No fault could then occur in the insulator without being instantly detected; and even a break in the copper, inside the insulator, would be shown by a sudden fall in the leakage, owing to the shorter length of cable which would then be under the action of the test. A simultaneous injury to insulator and conductor would be still more obviously indicated; but such a plan as this would result in voluntarily throwing away the assistance to be derived from intelligent observations on shore, which, it will be seen in the next lecture, may give important assistance in determining the position of a fault when it does occur. To meet this dilemma plans have lately been devised by which an insulation test on the ship and a simultaneous insulation test on shore can be nearly constantly maintained; speaking can be practised at any moment by ship or shore, and even during the transmission of messages the insulation test need not be wholly suspended. The first of these plans, in order of publication if not of conception, is due to Mr. Willoughby Smith. The connections required are shown in fig. 4. C Z is the ship battery; E_2, the ship earth plate, or sea connection; G, the marine galvanometer; A B, the cable, connected at the shore end with a great resistance R, equal to say the insulation resistance of four or five knots of cable. G_1 is a very delicate galvanometer on shore, placed between the resistance R and the earth plate. When these connections are made, a slight deflection on the ship galvanometer, G, will indicate the normal leakage of current through the gutta percha. Almost the full tension of the battery will act on R, and cause a feeble current to pass through this resistance, causing a moderate deflection on G_1. This feeble current will, of course, add to the leakage

FIG. 4.



indicated by G; but if R be equal to the gutta percha of say five knots, and A B be 1,000 knots long, the leakage through R will only add $\frac{1}{200}$ part to the deflection on G, and this may be neglected. A fault of insulation occurring in A B will instantly increase the deflection on G, will lower the tension of the battery acting on R, and so diminish the deflection on G_1. Ship and shore will both be advised of the misfortune. A break of continuity in the copper of A B, without loss of insulation, will diminish the deflection on G, and wholly stop the deflection at G_1 after a little while; thirdly, if the cable breaks altogether, there will be a great increase in the deflection of G, and a total cessation of all deflection on G_1. The shore can, without altering the connections, communicate with the ship by making shorter or longer contacts between the earth and the cable at o. This will cause corresponding deflections on G, but if a resistance be inserted between O and the earth, the deflection on G will be small, so that any considerable fault of insulation would still show on G, by causing a sudden and permanent alteration in the mean deflection even during the signals. The ship can signal to the shore by reversing its battery or by simply increasing and diminishing its tension. The insulation test on board would, the lecturer presumes, be wanting during these signals. It is to be hoped that this or an equivalent system will be adopted in future. It gives perfect freedom from routine, and a greatly-increased chance of detecting any fault the instant it occurs. This is the more important, as faults almost always do occur on board ship, and either in the top flake of the coils or in the machinery. In the next lecture Professor Thomson's plan of attaining the same object will be described.

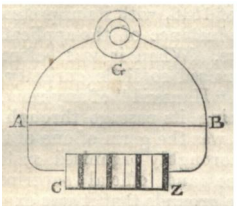
APPENDIX II.

METHOD OF MEASURING THE RESISTANCE OF A BATTERY.

First make the connexions, shown in Fig. 5, where CZ represents the battery to be tested; G, the galvanometer;

and AB, a short wire. The resistance of the conducting wire of the galvanometer must be known, and let it be

FIG. 5.



called equal to *a* units. Then adjust the resistance of AB so that it shall be equal to one unit, and observe the deflection of the galvanometer. Next break the connexion at AB, and introduce a resistance R, as shown in

FIG. 6.

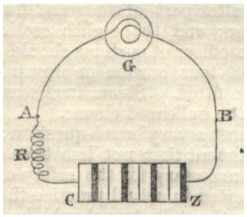


Fig. 6. Adjust this resistance till the deflection is the same as before; let the resistance at R, when thus adjusted, be called *b*, then the resistance of the battery, or, more strictly, the part of the circuit ACZB, will be equal to $\frac{b}{a}$. If it be not convenient to make AB exactly equal to *one*, any other convenient resistance *c* may be taken, and then the resistance of the battery will be equal to $\frac{cb}{a}$.

TWELFTH ORDINARY MEETING.

Wednesday, February 21st, 1866; Professor Huxley, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Betjemann, G. W., 38, Pentonville-road, N.
Creed, H. Herries, Windham Club, St. James's-sq., S.W.
Curtis, John, 111, Westbourne-terrace, W.
Freutel, Henry, 124, Kingsland-road, N.
Hutton, T. Maxwell, Summerhill, Dublin.
Longdon, Frederick, Derby.
Northway, John, 27, Great Tower-street, E.C.
Woods, Miss Elizabeth, 27, Hyde-park-gardens, W.

The following candidates were balloted for, and duly elected members of the Society:—

Beales, R., Congleton.
Davis, James, 2, Harley-road, West Brompton, S.W.
Farnham, Edward, Lordship-road, Stoke Newington, N.
Gale, James, 5, College-terrace, Belsize-park, N.W.
Marsh, John, West-bar, Leeds.
Milnes, Thomas, Zetland-lodge, Southport.
North, Charles Augustus, 1, Earl's-court-road, Kensington, W.
Sefton, Earl of, 53, Grosvenor-place, S.W., and Croxteth-park, Liverpool.
Spong, Rev. James, Mortimer-house, De Beauvoir Town, N.W.
Swindells, George, Bollington, Macclesfield.
Taylor, James, 209, Sloane-street, S.W.
Tanqueray, William Henry, Vine-street, Bloomsbury, W.C.
Torrens, Captain Alfred, Junior United Service Club, S.W.
Wace, John Richard, 45, Baker-street, W.
Ward, Lieut.-Colonel Francis Beckford, Guessens, Welwyn, Herts.

The Paper read was—

ON MODERN LEGISLATION IN REGARD TO THE CONSTRUCTION AND EQUIPMENT OF STEAM SHIPS.

By THOMAS GRAY, Esq., H.M.C.S.

"The Legislation since 1835 has, in many respects, been judicious and beneficial, though in others it has been carried to excess. When so much has been done, errors and omissions have been perhaps unavoidable. . . . . Your committee are of opinion that the scope of legislation, unless in exceptional cases, ought to extend no further than to secure solidity in the construction and sufficiency in the equipments of the ship; and that various minute regulations, now specially enforced by Act of Parliament, should be watched by the Board of Trade, with a view to remove any reasonable objection of undue official interference with the liberty of action of owners; and to make those regulations conform to the rapidly improving spirit which pervades every branch of scientific and maritime enterprise."—*Select Committee on Merchant Shipping*, 1860.

"I would suggest that it should be optional to shipowners who might choose to do so (not compulsory, but optional to them) to tender their ships to the Board of Trade surveyors, to be examined by them in the same manner as passenger ships are now examined, whether such ships be intended for passengers or not; and that on doing so the Board of Trade surveyors having been satisfied in all respects, these vessels should be registered as such certificated vessels and a certificate be given to them by the Board of Trade, which certificate should be taken as proof that there was no default on the part of the owner unless any actual default could be proved, and that that should be taken as *prima facie* proof that he had done all in his power for the safety of his ship."—*Mr. A. Anderson's Evidence, Select Committee*, 1860 *p.* 288.

"Meddling and muddling."—*Speech of Mr. Henley, President of the Board of Trade.*

INTRODUCTION.

It would be no easy task, and perhaps it would be impossible to determine by fixed rules, the proper limit to which private energy and skill should be left unfettered by legislative enactment, and at which Government interference and official supervision should begin. Whilst, on the one hand, it may be generally admitted that there are many cases in which it may be not only expedient, but proper, that Government should interfere, *e.g.*, to prevent a person or a body of persons from poisoning the water used, or infecting the air breathed by others, and to stay one person from inflicting harm by aggression on others, there can be no question that Government interference is not only unnecessary, but may really become vicious if it attempt to attain an end by official inspection and supervision that can be better attained by the development of free and healthy competition, and by the self-interest and emulation of the trader, since it fetters the development of trade, it stands in the way of the advancement of science, and it interferes to the prejudice of the liberty of the subject.

Much good may be done by statutory regulations for mutual convenience, *e.g.*, for ships meeting and passing on the high seas; but surely no permanent good can be effected by statutory restrictions in points of detail for governing the concerns of trade and of daily life; for example, by restrictions respecting the building of factories and workshops, or the building, equipping, and navigating of ships.

We propose to take into consideration to-night a few examples of modern legislation in which the safety of the subject and the advancement of the commerce of the empire have been sought through the medium of parliamentary restrictions; and we would discuss the question

whether the objects in view have been attained; and, granting this, whether they have been attained in the easiest and surest manner.

The enactments for consideration are parts of the Steam Navigation Acts of 1846, 1848, and 1851; the Merchant Shipping Act of 1854; the Amendment Act of 1862; and the Chain Cables and Anchors Act of 1864; and the objects sought to be obtained are set forth in the preambles to these acts, as follows:—"For regulating the construction of sea-going vessels; for preventing the occurrence of accidents as far as possible in steam navigation; for requiring sea-going steam vessels to carry boats; for the better security of lives and property afloat in sea-going ships," &c.

I.—BULKHEADS.

The first question for consideration has reference to watertight partitions in iron steam-ships, known as "bulkheads."

1. The hull of a ship is neither more nor less than a strong hollow box. It is therefore obvious that, in the event of any part of the sides or bottom being stove in, the water will find its way from the part stove in to the whole of the interior, unless there be some contrivance to confine it. Watertight partitions, or "bulkheads," are or ought to be fitted in iron steamers for this purpose.

2. That these bulkheads are not a modern invention, appears from a paper read before the mechanical section of the British Association at Liverpool, on the 15th September, 1837, by Mr. C. W. Williams, of the City of Dublin Steam Packet Company.* From that paper it appears that the plan of dividing a vessel's hull into sections, each of which should be completely watertight, has long been known and practised by the Chinese in their trade barges. In China the several watertight compartments are under lock and key, and are appropriated to separate shippers.

3. In the United Kingdom, watertight compartments appear to have been first applied in 1835, to the "Garryowen," an iron steamer belonging to the City of Dublin Company, and to have been subsequently fitted to most of the steamers, both wood and iron, belonging to the same company.

4. On the first application of bulkheads in this country, a practical question suggested itself, viz.—How many of these partitions are necessary to ensure safety? Mr. Williams studied this question carefully. He shows in his paper of 1837, above referred to, that the division of the hull into *three* compartments, by two transverse bulkheads, is objectionable, on the ground that if a ship so fitted were to get stove in at the intersection of either bulkhead, two compartments would fill, and the vessel would go down. He then tried three partitions, dividing the vessel into four compartments, and after careful investigation rejected that number as unsuitable, and he finally came to the conclusion that the least number of sections necessary is five, made by four watertight transverse bulkheads.

5. In 1837, when Mr. Williams read his paper, seven vessels had already been fitted with iron bulkheads on his plan. The engineer, designer, shipowner, and insurer are generally pretty well alive to their own reputation and their own interests, and, as a matter of course, they appreciated the Chinese invention, introduced to notice by Mr. Williams. The *Great Britain*, the first large iron steamer built in this country, was built in 1840. She has six transverse bulkheads, dividing her into seven compartments. Until 1846 there was no law to compel the shipbuilder to adopt any particular invention. He was at liberty to take up, in the whole or in part, or to reject altogether Mr. Williams' plan of "bulkheads." That it was not rejected, the case of the *Great Britain* and other vessels prove.

* Published by order of the House of Commons, in Parliamentary Paper, No. 319, July 15, 1864, p. 169.

6. In the year 1846 it was thought that the time had arrived for a more general application of bulkheads to iron ships, and accordingly an Act was passed, with this and other objects in view, intituled "An Act for the Regulation of Steam Navigation, &c." The Steam Navigation Act of 1846, with its unpretentious title, is a very remarkable instance of the application of the thin end of the wedge. When it was before Parliament it appears to have raised so little curiosity that no mention is made in "Hansard" of any remarks or debates respecting it during its passage through either House, and yet this Act was the germ of one of the most extensive and most thoroughly organised systems of Government interference and official superintendence now existing. On the grounds that it was expedient to make provision for "regulating the construction of sea-going steam-vessels, and for preventing the occurrence of accidents in steam navigation," the second section of the Act provided that all steam-vessels of 100 tons burden and upwards should in future be divided by water-tight partitions, so that the fore-part of the vessel should be separated from the engine-room by one of such partitions, and the after part of the vessel from the engine-room by another; and the eighth section of the Act provided that no officer of customs should allow any iron steam ship of 100-tons burden or upwards to go to sea unless she was so fitted. Steam tugs were, all through, exempted from the bulkhead clause.

7. We now meet a very broad question:—It had been proved by experiment that not less than five transverse bulkheads were necessary for the safety of an iron hull. It had been accepted in actual practice that an iron hull of the size of the *Great Britain* should be divided by six transverse bulkheads, into seven compartments, and by longitudinal bulkheads into still more compartments; and yet the Legislature, by the Act of 1846, only required two transverse bulkheads, and no longitudinal bulkheads at all. It had, as we have seen, been accepted in actual practice as a fact, that bulkheads, if sufficient in number, and if properly placed, are essential to the safety of an iron hull. This being the case, would it not have been better, and would it not have been more in accordance with the spirit of our institutions, to have left the matter in the hands of the persons most interested, to find a proper application, and a fair development of the details of construction, rather than to have interfered, especially when that interference fixed, by positive enactment, a rule to be applied to all steamers, without reference to the varying requirements of their construction, build, and dimensions, the service on which they were to be employed, or the description and quantity of cargo they were intended to carry?

8. The Act of 1846 (which contained other provisions besides those relating to bulkheads) was not well received, and was evaded; and in 1848 it was found necessary to pass a further Act to "compel" owners of steamers to attend to the provisions of the former Act. With this additional act the owners appear to have gone on for another three years; when, in 1851, the "Steam Navigation Act" was passed. This Act consolidated the provisions of the former Act, and contained many new provisions, of which mention will be made hereafter. The clause relating to bulkheads was re-enacted, and was extended to all vessels without reference to tonnage, instead of being limited to vessels of 100 tons and upwards as before.

9. At the time this clause was framed there were but very few screw steamers, and although intended to meet the case of all iron steamers, it was in reality only adapted to meet the case of paddle-wheel steamers, in which the engine-room is in the centre of the ship, and in which the bulkheads placed before and abaft the engine-room would divide the ship into three parts, equal, or nearly equal.

10. The time now came when screw steamers made their way, and when the dimensions of iron ships generally were assuming and even exceeding the proportions

of the *Great Britain*. Builders, insurers, and owners now found out, as Mr. Williams, of The City of Dublin Steam Packet Company, had found out in 1837, that, except in the case of very sharp vessels, in which the engine-room was admidships—vessels only suitable for carrying mails—two tranverse bulkheads alone were wholly useless to keep the vessel afloat in the event of damage to either compartment. In the case of screw steamers, in which the engine-room was right aft, to comply with the Act, and to place one partition before the engine-room and one abaft it, was utterly useless, and even ridiculous. They, therefore, either added more bulkheads than the Act of Parliament required, or they met the letter of the Act by constructing flimsy and inexpensive bulkheads instead of strong ones.

11. In 1854 the *Golden Fleece*, of 2,768 tons, was built with *six* watertight compartments, and in the same year the great Act known as the "Merchant Shipping Act, 1854," was passed. This Act re-enacted many of the provisions of the former Acts, and, amongst others, the now celebrated Bulkhead Clause, which required every steamer to have *two* tranverse bulkheads. With a view to meet the case of screw steamers, and also with a view to prevent the evasions of the former Act, the Act of 1854 provided that the partitions, instead of being as a matter of course one before and one abaft the engine-room, should divide the ship into three equal or nearly equal parts, that the partitions should be of *equal strength* with the side plates of the ship, and that screw steamers should have, in addition, a small watertight compartment inclosing the after extremity of the screw shaft; and no officer of customs could legally allow any iron ship to proceed to sea, or to ply on any voyage or excursion, unless so fitted. These provisions applied equally to the largest and to the smallest iron ship afloat. They applied to the *Scotia* and *Persia* of nearly 4,000 tons, to the *Great Eastern* of 20,000 tons, and to the *Lady Bird* of 9 tons. Vessels crossing the Atlantic, and vessels plying on the Dee above Chester, or on Lake Windermere, were to have bulkheads placed and constructed according to one unvarying rule.

12. How was a collector of customs to know that a ship was properly constructed? that her bulkheads were properly placed? and that they were watertight? In the case of steam ships carrying passengers it is true that the vessels were surveyed, and that he had the declarations of the surveyors; but what was he to do in the case of vessels that do not carry passengers, and of which no survey is required by the Act? Here is a case in which the Act provided that a ship shall not go to sea unless fitted with certain bulkheads, but did not provide for a survey to ascertain the fact. As might have been expected, the Bulkhead Clause (which, as has been shown, was really valueless) soon became a dead letter in the case of cargo steamers.

13. There were also strange inconsistencies in applying the rule for dividing a ship into three parts. If an owner wanted a comparatively small engine-room in the centre compartment, with a long saloon at either end of the vessel, he would contend that the Act intended that the ship should be divided according to the cubical contents of each section; but if, on the other hand, for the purpose of attaining great speed, he found it desirable to allot a great space to the engine-room, then he divided his ship into three equal, or nearly equal, parts according to the length.

14. By the year 1862 it had become a matter of common observation and notoriety that the bulkhead known as the "collision" bulkhead—a small bulkhead in the fore part of the ship, above and beyond anything required by the Act, was, in a general way, in cases of collision, of far more value than the partitions required by the Act. It had also been by this time admitted that two tranverse bulkheads alone in a ship, instead of being the rule, should be the exception, and that the rule contained in the Act was no rule at all; and it will be found on reference to Table I., appended to this paper, that the number of steam vessels lost on our coasts had not decreased.

15. There were in 1862 only two courses open to the legislature; the first was to frame an Act with new rules, to organize a more strict supervision, and to punish evasions by more severe penalties; the second was to repeal the enactment altogether. The latter course was adopted, so that after repeatedly delaying steam ships from going to sea, after racking the brains of engineers and inventors to find out all sorts of contrivances and inventions for fitting doors in useless partitions that would close in cases of emergency, and after putting the owners to expenses and delays innumerable, the bulkhead clause was repealed.

16. Owners, designers, builders, and engineers, are at last left to apply their capital, experience, labour, and skill, in constructing an iron hull according to the manner experience teaches them to be the best. Many people look with regret on the repeal of the bulkhead clauses; but what is really the result? Do we find that ships are built with fewer bulkheads, or that the lives of passengers are placed in greater jeopardy than they were before on this account? On the contrary, if in taking up a newspaper, we turn to the shipping and engineering intelligence, we find an announcement that some well-known line or firm is having a splendid ship built to exceed in speed, accommodation, and beauty, everything attempted before; and that she is to be divided by four or five, or sometimes six watertight compartments, not only by athwart-ship, but by longitudinal partitions.

17. Again, as to existing passenger ships, do we find their partitions neglected so as to become useless because the Act has been repealed? On the contrary, we know that owners and underwriters are too much alive to their own interests. As experience taught them to place bulkheads in their ships in excess of the statutory requirement, so that experience, coupled with self-interest, teaches them to continue to provide bulkheads. From cases innumerable we may select, as cases in point, collisions between the *British Queen* and *Carolina*, in the Mersey; and the *Samphire* and *Fanny Buck*, in the channel. In the case of the *British Queen*, she had five partitions before the engine-room, and, although she was cut down nearly to the keel, she was saved without the water even *touching* one of the old parliamentary bulkheads. Had she been fitted in accordance with the Act, she would have had a space before the engine-room of 90 feet, just half the entire length of the vessel, and she must have been lost. In the case of the *Samphire* and *Fanny Buck*, we have a steel vessel, built with a bulkhead forward, in addition to the bulkheads required by the Act, and these bulkheads are kept efficient although the clauses are repealed. The *Samphire* was struck by the *Fanny Buck* about the spot where this additional bulkhead joins the side of the ship. The bulkhead was torn away by the collision, and the entire fore-part of the vessel was filled. But the *Samphire* is one of those sharp mail steamers, in which the division of the hull into three compartments is comparatively safe. But the division of the *Samphire* is neither according to length nor capacity. Had the *Samphire* had full bows instead of sharp bows, or had there been a sea on, or had she been struck at the spot where the foremost parliamentary bulkhead joins the side of the ship, or had she been struck aft, she would have verified, by most lamentable results, the experiments made by Mr. Williams as to the necessity of five compartments. The Surveyors for the Board of Trade made a series of experiments with a small metal hull, and they found that no arrangement whatever, dividing the hull into three equal sections by two partitions, could in any case keep the vessel afloat. Besides this, the *Sibyl*, *Waterman* 11, *Waterman* 5, and *Waterman* 7 have at different times got stove in on the Thames, and have verified the experiment. We know now that to fit a large iron ship in accordance with the statutory requirement alone, would be to send her forward to probable destruction.

19. The Bulkhead Clause was repealed, not because

bulkheads, if sufficient in number and properly placed, were thought to be unnecessary, but because experience had shown that legislative interference on the subject was useless, and even mischievous, and because it was believed that in this respect owners, designers, and builders knew their own business better than an Act of Parliament could teach them. The result has proved this to be the case.

It may be asked why I have dwelt so long on the Bulkhead Clauses, seeing that they are things of the past? The answer is, that although they are things of the past, and although we can now see that those clauses were absolutely vicious, as having led to great loss of property and much loss of life, they were, for the period between 1846 and 1862, deemed of exceeding importance; and, further, that other clauses, now deemed to be of exceeding value, may, under a somewhat similar process of careful examination, be proved, in like manner, to be either absolutely vicious, or to be inoperative, and therefore delusive.

II.—Boats of Sea-Going Ships.

The next question for consideration has reference to the boats of sea-going ships.

1. By the Act of 1846 it was enacted, that no vessel of 100 tons burthen or upwards, except vessels employed in the whale fishery, should proceed to sea unless supplied with boats, varying in number and cubic contents according to the tonnage of the vessel, and if she carried more than ten passengers one of the boats carried was to be a "life-boat," and the ship was also to be provided with two life-buoys. The greatest number of boats required to be carried in the largest ship was four, and that number was to be carried by ships of 800 tons and upwards, whether coasters or over sea.

2. One point to be specially remarked, with reference to the statutory regulations as to boats, is, that their number and cubical contents were, by the Act of 1846, and are at the present time, determined solely by the tonnage of the vessel, and do not vary according to the service on which she may be employed, nor according to the number of persons carried. This point, it will be shown further on, has mainly contributed to the Boat Clause becoming a dead letter.

3. The "Steam Navigation Act" of 1851 contained very stringent regulations on the subject of boats. A distinction was, for the first time, made between the number of boats to be carried by sailing ships and steamers of like tonnage. A steam ship of 500 tons register was, by the Act, required to carry the same number and description of boats as a sailing ship of 800 tons. The number of boats required to be carried by the largest ship now became five instead of four.

The Boat Clause of the Act of 1851, like the Bulkhead Clause, illustrates the obstructive character of this class of legislation. It makes no provision for inventions and innovations. In speaking of steam vessels it ignores the existence of screw steamers altogether when it states that "in the case of 'steam' vessels two paddle-box boats may be substituted for any two boats named in the Table."

4. By the time that the Merchant Shipping Act of 1854 was passed large ships had become more common. That Act accordingly, instead of taking 500 tons as the highest tonnage named in the boat scale, took 1,000 tons. The number and contents of the boats to be carried were, as in the former Acts, determined by tonnage alone. Each ship was to carry two life-buoys as before, but in the case of sailing ships of 150 tons burthen and under, not carrying passengers, a substantial boat, sufficient to carry the crew, might be provided instead of the boats named in the Act.

5. One or two examples will show how this scale applies:—A sailing ship of 210 tons carries on the average about twelve hands all told; she is required to carry either three boats of 750 cubic feet, or two boats, one of which must be a launch twenty feet long and the other a life-boat, and she must also carry two life-buoys. A steam-ship of 121 tons must carry similar boats to the sailing vessel of 210 tons, whether she is a passenger steamer or not. If she is a passenger steamer she will sometimes, according to the lists published by the Board of Trade, carry between 500 and 600 persons to the three boats and the two life buoys. If she is not a passenger steamer, but is, for example, a screw collier, she will have on board about twenty hands for the same boats and life-buoys. Again, a sailing vessel of 601 tons must carry five boats of 1,463 cubic feet; or if she does not carry five boats, she must carry four boats—one 16 feet long, two 24 feet long, and one launch 25 feet long; one of these boats must be a life-boat, and she must carry two life-buoys. These four or five immense boats will, if the vessel is not a passenger ship, be provided for the safety of about twenty-five people, so that five persons could go in each boat, and each person could have the twelfth part of a life-belt to himself. A steam ship of 361 tons must carry boats and life-buoys of the same number, size, and description as the sailing vessel of 601 tons, and she may carry from 1,200 to 1,300 passengers, so that she will have from 250 to 300 people to each boat, and about the 700th part of a life-buoy to each person. On the one hand it will be seen that there are not enough hands on board a vessel to save the boats, whilst on the other hand there are not enough boats to save the passengers and crew; and that the life-belts required by the Act are utterly inadequate.

6. It will be seen from the evidence taken before the Select Committee on emigrant ships, in 1854, that in some steamers crossing the Irish Channel from fifty to seventy cork belts are provided by the owners, because they think that, as a matter of duty, they should make ample provision for the safety of the passengers; whilst we find that in some other ships, heavily laden with passengers, and crossing dangerous and much frequented parts of a narrow sea, two or perhaps four life buoys only are provided. In the one case the Act of Parliament is disregarded altogether, and ample provision is made in spite of it; and in the other case the Act of Parliament is complied with, and the minimum of safety is the result.

When this class of legislation is operative it is frequently vicious because the minimum of necessity must be adopted as the maximum of efficiency, and where it is inoperative it is mischievous and delusive, since it leads the public at large to believe that it provides for cases that it never reaches.

7. The existing enactments respecting boats are evaded by the majority of coasters and home trade vessels, because they are beyond reason, and because there is no provision to secure compliance. It is true that the Act says certain boats shall be carried by these ships, but it makes no provision for ascertaining that they are carried; whilst as regards passenger steamers, the only class of vessels in which the Act is not inoperative, the Board of Trade have taken upon themselves, in contravention of the Act, to direct that in some few cases where the number of passengers carried is small, certain boats required by the Act may be dispensed with.

8. When an emergency arises we know but too well that the boats which have been passed by the surveyors of the Board of Trade, of the Emigration Office, of the Admiralty, and Post-Office, either will not "lower" properly, or, if they are lowered, do not swim. In the case of the *Samphire* and *London*, where efficiency had been sought without regard to cost, we find that "all the boats were fitted with patent lowering apparatus, which however excellent in daylight, requires a certain amount of coolness and skill to work effectually in a dark night. Hence the loss of life that ensued in lowering one of the boats, and the clumsiness in lowering the other;" * and that "the two pinnaces and port cutter were cleared away ready for

* See report of Messrs. Astley and Mummery to the Board of Trade.

lowering, and bread and water put into them. The starboard pinnace (an iron boat) was launched, and went down immediately." This same iron boat had already been fitted with cork, on the suggestion of Mr. Gladstone, the shipwright surveyor.* And yet we read case after case in which a smack launches a cockle-shell of a boat in the worst weather, in a heavy sea and with rude gear, and rescues the crew of a water-logged ship in successive trips. This boat has not had the benefit of a statutory survey, and yet she is efficient.

9. It is admitted that, as regards boats, the Act is, to a great extent, a dead letter. It generally happens that in the greatest emergencies the boats, with all the statutory inspection, fail. Something must be done—one of two courses is open. First, for the legislature to pass a short Act containing an amended scale, in which the boats and life buoys shall be proportioned to the number of passengers on board, and in which provision shall be made for extended inspection and surveillance; or, secondly, that the boat scale shall be repealed entirely, and that the owners of a ship shall be held responsible for providing sufficient boats and life buoys, according to the exigencies of each case, and for keeping them efficient and ready for use. The experience gained by the operation of the bulkhead clauses, and by the result of their repeal, will invite us to consider to night whether the latter course is not the proper one.

III.—Safety Valves.

The next enactments for consideration are the clauses relating to safety valves on the boilers of marine engines.

1. The act passed on the 28th August, 1846, provided (sec. 14) that the owner of every steam vessel should transmit to the Board of Trade twice a-year, "under the hand of an engineer surveyor approved by the Board, a declaration of the sufficiency of the machinery." The Board of Trade were required to register these declarations, to forward to the owner a certificate of registration, and a penalty not exceeding £100 was to be the punishment for a non-compliance with the statute.

2. This enactment took effect on the 1st January, 1847, and on the 27th August of that year the boilers of the *Cricket*, half-penny steamer, exploded, resulting in the loss of six killed and twelve wounded. From the facts that came out at the inquest, it appeared that the provisions of the Act as to surveys had afforded no security to the public. These provisions had been delusive. They had not led the owner to be careful in the selection of an engineer, nor had they led the engineer to be careful in the management of his boiler. The contrary appeared to be the case. The engines had become leaky in the trunnions, the master and owner complained to the engineer of the loss of speed, and the engineer tied down the safety-valve. A witness on the inquest stated that the engineer "tied the end of the lever down by two pieces of spun yarn to two spike nails, which were driven into a beam athwart the vessel," and that he (witness) was dismissed from the service because he made such an "oration" one Sunday when the engineer, who was drunk, had got the valves fast, and the pressure so heavy that the water was rising with the mercury in the pressure gauge. The engineer was tried, and on being convicted (says the *Annual Register*) the Lord Chief Justice Denman, "after commenting with severity upon the fearful consequences of such proceeding, sentenced him to two months' imprisonment."

3. The Act of 1846 was frequently evaded, so that an act was passed in 1848 (as has been stated) to compel owners to transmit surveyor's declarations to the Board of Trade, and to exhibit a copy of the Board of Trade certificate on the vessel; and an additional fine of 10s. a-day for delays in transmitting declarations, and a penalty of £20 for not placing the certificate in a conspicuous place on board, were imposed.

4. By the year 1851 it was found that the Acts of 1846 and 1848 were almost a dead letter as regarded the safety-valves and surveys, and it was then thought to be time for some rigorous measures to be taken. Accordingly, the Steam Navigation Act of 1851 was passed. This Act contained fifty-one clauses. It created a great number of new offences, and made them punishable by fines of various sums, from 10s. a day to £100 in one sum, or with imprisonment in proportion. It re-enacted most of the clauses of the former Act, and it placed in the hands of the Board of Trade the duty of appointing and removing surveyors, and of regulating the mode in which surveys were to be made. It gave the same department power to cancel and withdraw certificates, and to send their surveyors on board any vessel, at any time, to ascertain any particulars. With regard to safety-valves a clause was expressly inserted to the effect that no ship was to go to sea, or to steam on any rivers of the United Kingdom, unless she was provided with a safety-valve on each boiler "free from the care of the engineer," and out of his control and interference when steam was up; and surveyors were required to examine and report on the safety-valves in question, and to fix the weights to be carried, and consequently the pressure of steam in the boilers.

5. Things went on pretty well for a short time, with an occasional collapse or explosion of no serious moment, and not doing sufficient harm to call public attention to the subject. The Act came into operation on the 1st June, 1852, and in 1853, just as it was becoming known, and the surveyors appointed by the Board of Trade were warming to their work, the *Times*, of Glasgow, blew up off Dublin, scalding 33 people and absolutely killing 12. From the evidence elicited during the investigation, it appeared that the vessel had but recently been surveyed by the Board of Trade surveyors, that she had a Board of Trade certificate, that the safety-valve was in accordance with the Act, and yet, in spite of all the boiler blew up.

6. This case is one that furnishes a splendid illustration of the vice of a system which makes the safety of the public rest on the vigilance of an inspector or surveyor, instead of on the care of an owner;—legislation which tends to remove responsibility from the shoulders of the owners, and of their servants where it ought to rest, and to place that responsibility on official surveyors, where it ought not to rest, and where, as a matter of fact, as opposed to theory, it cannot rest.

7. The boiler of the *Times* had been patched. The surveyor was not aware of this; he never saw it; and yet he was found guilty of manslaughter by a coroner's jury and received a severe reprimand from the Board of Trade officer who conducted the inquiry, for not locking up the valve and giving the key to the master. It is true that, as a surveyor, he ought to have found it out—as a detective he was at fault. But it is also true that this lamentable loss of life might have been prevented if the chief engineer of the vessel—a servant of the owners, who did know of it, and who actually accompanied the surveyor to the boiler—had called the surveyor's special attention to it, instead of leaving him to give his certificate, on the supposition that the boiler was sound, and in utter ignorance of the patch. The penalty ought rather to attach to the owners and their servants, who must be aware of all defects, than to the surveyors, who may sometimes be misled by *suppressio veri*. If a sore place or a defective rivet in a plate of an iron hull, or a crack in a stern-post, or a weak place in a boiler can be concealed cunningly, for the surveyors to give their declarations without first putting the owner to the expense of repairs, the owners are all the better off, but the insurers and passengers, through no fault of their own, are the sufferers, and the public are misled.

8. The case of the *Times* showed that the system of statutory supervision was not then by any means perfect as regards the boilers and machinery, as other cases had shown that it was not yet perfect as regards boats and bulkheads; and in 1854 the "Merchant Shipping Act"

* See report of evidence in case of the *London*, as published in the daily papers.

again dealt with the question. To ensure the surveyors doing their duty now a Surveyor-General was appointed. The Safety-Valve Clause was re-enacted as follows, *viz.*: —Every steam-ship of which a survey is required, "shall be provided with a safety-vale upon each boiler, so constructed to be out of the control of the engineer when the steam is up;" and if such valve is in addition to the ordinary valve it shall have an area not less, and a pressure not greater, than the area of and pressure on that valve. The surveyor is, by the Act of 1854, required to declare the limits of the weight to be placed on the safety-valve, and a penalty of £100 is imposed on any person increasing that weight.

9. As regards safety-valves, "The Board of Trade Instructions"* say (paragraphs 143 to 151) that "the valves are to be so fitted that the engineer may not have the power of increasing the weight on them when the vessel is under steam. The valve may be contained wholly within the boiler, and accessible through the manhole only," or "on the outside of the boiler, inclosed in a box sufficiently large only for the weights and the necessary motion for them; and, secondly, by a lock, of which the key is to be kept by the *master* of the vessel, who will be responsible should any additional weight or pressure be placed on the valve." These regulations are explicit. To carry them into effect surveyors were appointed with fixed yearly salaries, and these officers were not only to survey the machinery once every six months, but were to take frequent opportunities of visiting every ship arriving in the port; so that thus a constant system of official inspection and supervision was inaugurated, and was superintended by a surveyor general. This was in 1856.

10. On the 30th November, 1860, the boilers of the *Tonning* exploded. It appears, from the report of the inquest at Lowestoft, in the *Shipping Gazette* of 5th November, 1860, "that five men and three boys disappeared altogether at the time of the explosion, and were never heard of afterwards, that five people were landed, dead or dying, by smacks, and five badly scalded, and that out of 30, the whole number of persons on board, 17 only escaped alive; and out of these 12 only were uninjured." The *Tonning's* boilers were fitted in accordance with the requirements of the Act, and the Board of Trade detailed instructions. They had been surveyed by one of the Board of Trade permanent surveyors in the preceding June, and the vessel had a Board of Trade certificate, and yet the boilers exploded!

11. This case and its attendant circumstances deserve careful examination, as they bear out the conclusion arrived at in the case of the *Times*, whilst they show that, however conscientiously the surveyor may do his duty, the evils sought to be avoided are sometimes actually created by statutory regulations. It also shows that the regulations are not yet sufficient in detail or stringency if this system of minute statutory requirements is to be continued.

12. One of the most essential adjuncts to a safety-valve is lifting gear, to ease the boilers; but the Act, although it goes into details, does not provide for this. It rather forbids it than otherwise; for it says that the valve "shall be out of the control of the engineer when the steam is up." The Board of Trade, however, have in their instructions added to this clause, so that the surveyors are to read it as if it were "so that the pressure cannot be increased when the steam is up." But if a lifting gear is not fitted (and there are many valves without lifting gear even now), the Board of Trade surveyors have no power to require it under the statute; and if there is only one valve on the boiler, that valve without lifting gear will be locked up and the key given to the master. The locking-up is a mere delusion, because the padlocks generally used are sold by the gross or by the pound, and can be opened by a bent nail or wire. And there is nothing to prevent the weights from being increased when the steam is not up. If an engineer is dishonest he will increase the weight when the steam is down. If a master is conscientious, and is ignorant of steam, he will keep the key from one six months to another, and will not allow the valve to be opened. The loaded valve may burst the boiler; the locked-up valve may set fast and do the same. Thus, the probability of an explosion is not provided against in the one case, and the very elements of an explosion are actually provided in the other.

13. In the case of the *Tonning* the safety valves had been looked at by the surveyor, and locked up by him. The key was given to the master, who kept it, and nobody ever saw the valves again. The master never gave the key to the engineer. He had commanded several other steamers besides the *Tonning*, and had never been in the habit of giving the key of the safety-valve to the engineers. The engineer said he never thought it his duty to look at the Government valves.

14. Mr. Galloway, in his evidence, stated that "the surveyors made inspections in addition to the six-monthly surveys; that the two statutory-valves had been blown away and lost, and that of the two ordinary working valves under the engineer's control one had not been working for some time, and the other had not the appearance of being a self-acting one. If either of the valves had been fully open the explosion would not have happened."

Another engineer deposed that "the stays had been so far corroded that they would not, in his opinion, sustain 13 lbs." The coroner, in summing up, said the owners of the vessel would not be liable criminally unless they absolutely knew the fact that the boilers would not bear a due pressure; and they could not be liable moreover because at the very time the accident occurred the vessel was running with a proper certificate from the Board of Trade. By no possibility, however, could the slightest blame attach to the owners. The only person against whom it could be possible to return an adverse verdict would be the chief engineer, as he had charge of the boilers at the time the accident happened. With reference to the Government valves, he (the coroner) was much struck with an observation made by Captain Robertson, and also by the chief engineer of the ship, that it would be desirable to examine such valves more frequently from time to time. But it appeared from the evidence that all other engineers of steamers were in the habit of trusting entirely to the examination of Government surveyors, and therefore, although it might be very proper and desirable that engineers should look at Government valves, he did not think the fact of their not having been looked at in this instance ought to bear hardly against the chief engineer of the *Tonning*. One could scarcely expect the engineer of a steamer to look at the Government valves, unless some rule of a general character was laid down on the subject. It is needless to say that the Board of Trade did not agree with the coroner's summing up, and issued a circular to the effect that the survey does not relieve the owner and his servants of their responsibility.

15. In the case of the *Cricket*, the valves were left open, and a drunken engineer tied them down. In the case of the *Times*, the surveyor was kept in ignorance of the real state of the boiler, and received a severe reprimand from the Board of Trade for not giving the key of the locked-up safety-valve to the master. In the case of the *Tonning*, the valves were locked up, and the key given to a conscientious man, who would not open them in the absence of a government officer. The result was the same in each case—an explosion, but each worse than the former.

16. It must be evident from what has already been stated, first, that the Act, stringent as it is, is not the cause of our immunity from accident; secondly, that if it is to be relied on, it must either be made more stringent or to a great extent modified.

* These instructions can be purchased at the Queen's printers, for 2s. 6d.

17. It may be asked how is it that there are not more explosions, if the Act is so defective? The answer is, that the surveyors, the working staff, on whom the real duty and responsibility must rest, are practical men, and that they are looked on, in the majority of cases, rather as friends and advisers of owners, masters, and engineers, than as surveyors, inspectors, and detectives. They act as *ex-officio* consulting engineers to owners, and by their practical experience, by their tact, and by their sound common-sense, they are able to induce owners, by reason and for their own advantage and self-interest, to effect improvements and repairs without reference to the requirements of the statute; but wherever the statute has been of value, it has been in spite of, and not because of, the requirements respecting the details of construction. And it is by mutual confidence and good understanding that enactments, insufficient and comparatively useless and delusive in themselves, have been rendered harmless in very many cases; but in some cases, where a strict adhesion to the Act is relied on, the surveyors have great difficulty, and give their declarations in fear and trembling.

14. One of the great difficulties a surveyor is likely to meet with is in limiting the steam-pressure. In settling the pressure to be placed on the safety-valves, the engineer has two points to consider. Both these points frequently give much trouble—points on which the Act is silent, on which it would be impolitic, for obvious reasons, for the State to lay down any fixed rules, and yet points on which the chief surveyors throughout the country have had to come to a mutual understanding among themselves. I refer, firstly, to the proportion of area of safety-valve to grate surface; and, secondly, to the stay power of boilers.

18. The proceedings of the surveyors in passing safety-valves may be comprehended in a general way as follows:—They first ascertain the pressure that the stays will bear, at the rate of 5,000 lbs to the sectional inch. They then see that the safety-valve is not below the proportion of half-an-inch of area to each square foot of grate. They then place the proper weight on the valve. It must be here observed that the maximum of 5,000 lbs. pressure on stays, and the minimum of half-an-inch area of valve to a foot of grate surface, is not an arbitrary rule, never to be departed from in special cases, and likely to prevent improvement; that it is not a statutory rule, nor a rule made by any State department; but that it has been adopted by the surveyors amongst themselves, because it was found to fall in with the practice, for the time being, of the best makers of engines in the country. It would, we may conclude with certainty, be altered to-morrow, if it no longer coincided with actual practice.

19. To lay down a fixed rule, *e.g.*, a rule to limit the length of iron girders in railway bridges, to limit practical men in the use and application of material, is objectionable; but for practical surveyors to lay down a rule as a daily guide, embodying the known practice of the best makers and varying from time to time to keep pace with improvements and inventions, is advantageous, and, if minute official supervision is to exist, is necessary. The benefit of such a rule must have been shown in cases in which the safety-valves have been dangerously small, or in which an unsafe pressure may have been otherwise placed on the stays.

20. It is scarcely credible that at the present day the presence or absence of proper stays in a boiler should sometimes be urged by an owner as of no moment when endeavourimg to obtain a Board of Trade certificate, and yet this is the case. If it is so, the answer at once then is, the statutory surveys do good, because they prevent those boilers, imperfectly stayed and with small valves, from being used in steamers carrying passengers. But look back a little, and it will be seen that the explosions and loss of life mentioned have happened on board vessels coming under the statutory survey, and that the loss of life from explosions in vessels carrying the Board of Trade certificate exceeds greatly the loss in vessels not so certified. In fact there has been no serious explosion on board a steamer without a Board of Trade certificate. It must also be borne in mind that if there were no detailed statutory requirements, the owner of a steamer would have his responsibilities before his eyes, and would have his boiler properly made and worked, or would, if he used a dangerous boiler, do it on his own risk, and without the protection of the statutory details. But, as there are detailed regulations, if he meets these regulations and his defective boiler and valve manage to pass the surveyor, he would carry the Board of Trade certificate, and would, according to the mistaken views expressed in the Lowestoft case, allow the passengers on board his vessel to be blown up, on the authority of the statutory survey and certificate. And, again, we know that a Board of Trade certificate is, in many cases, obtained simply to sell a vessel, and, so long as the seller can sell his vessel as sufficient under that certificate, he will, if she is an old vessel, do as little as he can and only just enough to comply with the statute and pass the survey. If the boilers will hold out for a month (and they must be poor boilers that will not do this), and if they will only just stand double the working pressure under cold water, and without reference to stay power, that may be enough for a man who wants to sell an old vessel: but it would not be enough for a man who would work a boiler on his own responsibility, and it is not enough for the safety of the public; and yet some owners would think themselves sorely ill-treated if a statutory declaration and passenger certificate were not granted under the circumstances; and, moreover, the public at large, finding that they are in continual safety on board a passenger steamer, believe that this safety is due to statutory interference in details of construction.

IV.—Compasses.

The next subject for consideration is the clause relating to the compasses of iron ships.

This clause appears for the first time in the "Merchant Shipping Act, 1854," sec. 301.

I had written a chapter on the subject of compasses, but as the question has been so thoroughly reviewed, and so thoroughly ventilated lately, I thought it best to strike out my review of the facts, and in lieu to remark that the real point at issue between the President and Council of the Royal Society and the Board of Trade may be summed up in a few words by stating that the Royal Society wish to force the Board of Trade to undertake a system of compass supervision similar to the system adopted in the Royal Navy. The Royal Society are not prepared, however, with any practical rules for the guidance of the mercantile marine,—they want a compass department and officers established first, and the practical rules afterwards. The Board of Trade do not see the question in the same light. The Astronomer Royal and the mercantile marine do not agree with the Admiralty and the Royal Society as to the method of applying the corrections, and a third person now comes forward to remove the cause of difference altogether by demagnetizing a ship. The correspondence containing the facts has been published, and has doubtless been read by every one interested; so that that correspondence will serve as a basis for discussion better than any remarks I might make. I now pass on to the next subject.

V.—Anchors and Cables.

The next and the last subject for consideration is recent legislation respecting the ground tackle of ships.

1. Chain cables, both for mooring purposes and for ships' armour, were, it would appear, known in the time of Julius Cæsar.* They were revived for mooring ships at the beginning of the present century by Captain Brown (Brown, Lenox, and Co.), and they were recently used by way of defence in the *Kearsage*, during her celebrated encounter with the *Alabama*.

I do not propose to enter into any historical details,

* See note in Lemaire's edition of Cæsar's works.

nor do I propose to express any opinion on the merits of the various anchors and cables with which the seafaring man and the Patent Office are so familiar. Chain cables have now utterly displaced the hempen cables as moorings for ships. It is on her anchors and cables that a ship and her valuable freight of human beings and merchandize often has to rely for safety on a lee shore, and it is by the failure of cables that fearful losses are too frequently incurred, as in the case of the *Royal Charter*.

2. That iron cables have become shamefully bad there is no doubt, when we contemplate the number of anchors lost on our coasts in each year. There is no official return from which I can quote figures showing the exact number of anchors lost, but from a calculation of my own I am satisfied that somewhere between 700 and 800 anchors are picked up by boatmen on the coasts of the United Kingdom alone in each year. It is true that each of these anchors does not represent a bad cable, since many are slipped purposely, and some are lost through carelessness, or by the total wreck of a ship; but eliminating these, we may be safe in assuming that not much less than 400 anchors are lost annually on our coasts through bad cables. This being the case, it became a matter of serious consideration whether something should not be done to improve the manufacture, and to insure a sufficient test.

3. The matter was taken up by Mr. Laird, M.P. for Birkenhead, Sir James Elphinstone, and Mr. John Trotman, of anchor celebrity; and on the 23rd June, 1864, through their exertions, the Chain Cables and Anchors Act became law.

This Act provides "that it shall not be lawful for any maker of, or dealer in, chain cables or anchors to sell, or contract to sell, for the use of any vessel any chain cable whatever or any anchor exceeding 168 lbs. in weight, unless previouely tested and stamped" at a machine licensed by the Board of Trade; and it empowers the Board of Trade to license machines belonging to any "corporation, public body, company, or person or persons" passing the survey of the Board of Trade inspector. This Act has so far done good that it has called the attention of the public at large, and especially of the shipowner and insurer, to the fraud until recently existing in a certain class of the anchor and cable trade.

4. But it is a question whether this Act will really be of the great service that its promoters anticipated, or whether it is indeed what the promoters really desired. As it stands, it is a favourable example of an Act that does too much and yet too little. It gives the Board of Trade power to licence a machine as fit to test anchors and cables; but it provides no guarantee for the faithful and honest use of that machine when once licensed. It imposes a penalty for breach of its provisions, but it gives no power to an officer of customs to stop a ship without properly tested cables.

5. It errs, it has been alleged, in giving any maker the power to test his own cables for a certificate of public proof, and some even go so far as to say that it errs through not giving the Board of Trade power to regulate the selection of the iron for the manufacture of the cable, the process of testing, and the temperature of the testing-shed. But to my mind it errs grievously and fatally in making the test compulsory at all. Compulsory and stringent as the Act is, it is a matter of common knowledge and observation that it is evaded daily.

6. Public sympathy will with certainty be enlisted on the side of Mr. Laird and the promoters of the bill in their endeavours to save human life; and the majority will be with me when I say that I am wholly on the side of Mr. Laird and the promoters of the bill as to many advantages to be gained by testing-houses, properly established and properly used; but I wholly object to anything but public independent proofs. I am satisfied by observation, and I am confirmed in my conviction day by day, that the Act which does not now require this must be amended, or it will become a mere delusion, like other compulsory statutes. They rely on supervision and penalties, Government help, and Government prosecutions, rather than on self-interest.

7. From articles that have appeared in the public prints, and from questions put to and answered by Mr. Milner Gibson in the House, we know that great pressure was brought to bear on him to induce him to refuse to license a maker to test his own goods in his own yard for a public proof mark under the existing Act; but, however much Mr. Gibson might agree with the necessity for public test alone, his reply was in effect "How could he do so in the face of the Act?" The views, urged with great reason and force, were, in effect, "How can Mr. Gibson refuse to license Mr. Lenox as Mr. Lenox, or Mr. Parkes as Mr. Parkes, when Mr. Lenox or Mr. Parkes, by making their concerns into Lenox and Co. (limited), or Parkes and Co. (limited), and keeping the greater number of shares to themselves, could claim a license as a company? or, again, if he refused Mr. Parkes, Mr. Lenox, and Mr. Woods singly as manufacturers, how could he, as required by the Act, license them in the aggregate if they formed a testing company. It would, indeed, have been a fatal mistake, and, at the outset, the machines at Tipton (to which the Liverpool merchants specially objected) could not have been licensed, and the trade must have been stopped.

8. People who object to the Board of Trade granting a license to a maker under the act say, "We do not let a jeweller test his own watch-cases and plate, nor are we willing to allow him to affix the hall mark." Why then should a department of the State authorise a cable maker to test his own chain cables for public proof under the recent statute, and affix his proof-mark? The answer is perhaps as follows:—Assuming that the cases are analogous (and this remains to be proved), and assuming that the granting or refusing a license to an individual rests with any department of the State, then that department ought not to grant a license to allow a maker to test his own cables. But are the cases analogous? Here the argument breaks down. They are not analogous. The statutes are essentially different, and before the action in both cases can be assimilated the later statute must be altered to agree with the other. It is of course idle to argue on general grounds that because a certain course is adopted in one case it should also be adopted in all others. If this were so we should simply go on applying rules according to precedent indiscriminately, and without inquiring whether the precedent is good or bad.

9. To the honest and efficient manufacturer testing and superintendence under the Chain Cables Act are needless and useless; to the dishonest trader, with a licensed machine in his own works, the test is equally useless for public safety, but more mischievous, because he can alter it the moment he has obtained his license, and he can then give a certificate of proof with a bad cable tested at a false machine.

10. Whilst these objections can be urged against the existing Act, it may with reason be argued that public proving houses, worked by public servants or public corporations, and totally unconnected with trade influences, would be of value as a guarantee beyond dispute between buyer and seller, as they have usually been in the case of jewellery and plate, and on the whole, as stated above, a majority will be found in favour of such a test. But it must be voluntary to be *bonâ fide;* the moment it is made compulsory it becomes a delusion. The end sought might be attained if corporations had power to erect machines to be licensed by the Board of Trade, and if every purchaser had the power of having his chains tested at those machines at the expense of the seller, with the understanding that they were to be returned on the seller's hands if not up to the test. There would then, in a short time, be but few bad chains in the market. The maker would, for his own self-interest, provide a proper machine in his works, and for that self-interest he would use it efficiently, so as not to cheat himself. The shipowner would appreciate its value by

obtaining insurance at a lower rate. The insurer would not insure a vessel at the current rate unless her chains were represented to be efficient. The foreign buyer would make it a *sine quâ non* that his chains and cables were proof marked; and, above all, loss of life would diminish—a reality would be substituted for a delusion—and this would be effected not by compulsory interference and dictation, but by enlisting self-interest on the side of the trader, and by leaving trade to its own resources for free and healthy development.

CONCLUSION.

1. This paper is, as has been already pointed out, intended to open up a discussion of the question whether the objects sought to be attained by the detailed statutory regulations to which I have referred have been attained; and, granting this, whether those objects have been attained in the easiest and best manner.

2. Mistake is frequently made when, in speaking of an administrative department of the State it is said, "Why does this department do so and so?" or, "Why does not that department interfere to protect us?" People who ask these questions do not think that the department they are condemning may be tied down by the express provisions of a special statute. The question ought not to be, "Is such a department right in requiring this, or wrong in not requiring that?" but, "Is our legislature right in requiring this, or wrong in not requiring that?" And so to night our question is not whether certain statutory provisions are properly administered, but above and beyond that, "whether, on public grounds, those statutory provisions should exist?"

4. I have endeavoured to point out:—

(*a.*) As regards bulkheads, that the statutory regulations, if observed, would have caused ships to be sent to sea absolutely unsafe, and that safety has been obtained through a total departure from the statute; and I have given examples in which ships fitted according to the Act have been lost under circumstances in which ships fitted regardless of the Act have been safe.

(*b.*) As regards boats and life-buoys, that the boat scale is against reason, and opposed to experience; and that the provision for life-buoys allows the seven-hundredth part of a buoy to a passenger.

(*c.*) As regards safety-valves, we have seen that an explosion, each worse than the former, followed every addition to the stringency of the regulations; and that locking up the safety-valve, as required by the Board of Trade Regulations, and giving the key to the master, who knew nothing about steam, instead of to the engineer who did, was the cause of the worst explosion of all.

(*d.*) As regards compasses, whilst the Admiralty and Royal Society are at variance with the Astronomer Royal and the Mercantile Marine, and now that Mr. Hopkins proposes to take the bone of contention away from the philosophers altogether by demagnetising a ship, the Board of Trade are called upon to exercise "a more direct and systematic supervision over the adjustment of the compasses of ships of the mercantile marine," and are informed that "the theory of deviation, its causes and its laws, are thoroughly understood;" and that results have been obtained "suggesting modes for constructing iron ships." As the subject is so "thoroughly understood," it is to be hoped that the mercantile marine, in which there are some of the best seamen and most scientific observers of the day, will be able to avail itself of the "understanding," and that they will be able to appreciate the suggested "modes" of constructing ships. If the information is so thoroughly reliable, and the suggested "modes" of construction so good as to commend themselves, where is the necessity for statutory regulations and state supervision?—and if the information should not be reliable, and if the "modes" should not be believed in by practical men, the State ought still not to interfere.

(*e.*) As regards anchors and cables, the defects of the existing system have been pointed out, and a course that is likely to lead to better results, without any of the objections to the present system, has been suggested.

5. And now let me ask what has all the state nursing of the last few years led to, that people should want more of it? Does it not, in theory, lead to an abandonment of individual character and self-reliance, and has it not done so in fact?* There are some sterling officers of the mercantile marine whose individuality and self-reliance it would be impossible to impair, but, in too many cases, the good old maxims of the good old seamen seem to be forgotten under the paternal rule. All sorts of excuses are sometimes urged for not using the lead, or for not taking observations, or for relying on a compass-needle as an instrument of mathematical accuracy and precision. Scarcely a ship is now stranded on our coasts without the casualty being followed by a recommendation to the Board of Trade that a buoy, or a beacon, or a lighthouse, or a light vessel, or a harbour of refuge be erected, and this in two cases out of three when a single cast of the lead, or the commonest attention to seamanship would have saved the vessel.

6. There are present this evening many shipowners and ship-builders; we hope to hear from them whether they think it possible for a ship to be constructed and equipped without statutory regulations in details. If so, I ask them to say so. There are also many of the public here who may think that an owner and a builder ought to be looked after; to these I would suggest that before they ask for more Government supervision, let them show that it has saved, or that it will save, life and property. A synopsis of the Acts of Congress, issued by Mr. Chase, the secretary to the treasury at Washington, is appended. This abstract will show that, under the United States Government, a statutory code has been passed far more stringent than any ever passed in this country. The results we have heard of.

7. I will now conclude by reading one of the tables appended to this paper, viz., a list of 24 large vessels, of the aggregate tonnage of 16,074 tons, lost, with 460 lives, on the east coast of Ireland alone, from 1856 to 1865, with the cause of each loss; and I will ask you again, have we anything to be proud of in legislation that leads to such a result?†

APPENDIX.

Synopsis of the Act of Congress, passed August 30th, 1852, relating to Steamboats, defining the duties of the Masters and Owners required by the law, and the penalties imposed for its violation.

SECTION 1.—No papers to issue to any steamer carrying passengers until the provisions of this Act are complied with, and if any such steamer is navigated contrary thereto, the penalty is 500 dollars fine.

SECTION 2.—*Precaution against Fire.*—All combustible materials must be placed at a safe distance from heated metal; and any wood exposed to danger from heated metal or fire must be shielded by incombustible material. The inspectors will also require provisions to be made for blowing steam in the hold in case of fire, and also that spark arresters be provided to prevent sparks from being driven back from the furnace doors when drawing the fires or cleansing the furnaces.

SECTION 3.—Provides for double-acting forcing pumps and hose. Steamers of over five hundred tons burden must have three pumps; of two hundred tons and less than five hundred tons burden, two pumps; and all of less than two hundred tons burden, one pump, and hose two-thirds the length of the boat for each pump, to be kept in perfect order, and ready at all times for immediate use.

SECTION 4.—Relates to life-boats, one of which on each steamer must be made of metal; all ocean and lake steamers, of from five to eight hundred tons burden, must have three

* See Tables in Appendix.
† Table II.

life-boats; and from eight hundred to fifteen hundred tons burden must have four life-boats; and all of more than fifteen hundred tons burden must have six life-boats, all of which must be well furnished with oars and other apparatus, and at all times kept ready for use. Steamers navigating rivers only must have one life-boat made of metal, of suitable dimensions, furnished with oars, and kept at all times ready for use.

SECTION 5.—Provides for a life-preserver or float for each and every passenger, to be kept in convenient places, and always ready for use. It also provides for fire-buckets and axes. For all steamers of 500 tons and under, 20 buckets and 5 axes; from 500 tons and less than 600 tons, 25 buckets and 5 axes; of 600 tons and less than 700 tons, 30 buckets and 6 axes; of 700 tons and less than 800 tons, 36 buckets and 7 axes; of 800 tons and less than 900 tons, 39 buckets and 8 axes; of 900 tons and less than 1,000 tons, 43 buckets and 9 axes, and so on according to tonnage, up to 3,500 tons, all of which must be kept in good order and in suitable places ready for use.

SECTION 6.—Provides that there shall be sufficient means of escape convenient to passengers from main to upper deck.

SECTION 7.—No loose hemp, gunpowder, or other dangerous articles shall be carried as freight, without a special license for that purpose, under a penalty of one hundred dollars.

SECTION 9.—*Art.* 1.—Application for inspection must be made in writing by the master or owner. *Art.* 5 prescribes the mode of carrying gunpowder, burning fluids, materials which ignite by friction, and other dangerous articles, which must be kept in safes or chests, made of metal or entirely lined therewith, or one or more apartments of the boat thoroughly lined, at a secure distance from any fire. *Art.* 10 makes it unlawful to employ any person to serve as engineer or pilot who is not licensed by the inspectors; penalty, one hundred dollars for each offence. *Art.* 11 requires repairs to be made whenever necessary, in order to make the navigation of the vessel safe, and for the neglect of which, the master and owners are held responsible for all damage to passengers which shall occur from such neglect. *Art.* 12.—If any vessel shall be navigated (with passengers on board) after the inspectors have refused to give a certificate of approval, the penalties are the same as if she were run without a license, viz., five hundred dollars.

SECTION 10.—Where the number of passengers is limited, no greater number shall be taken on board the vessel. The penalty of this is to refund the passage-money and a fine of ten dollars for each person beyond the number allowed. And further, for the violation of any implied undertaking in regard to furnishing food, lodging, &c., or where the progress of the vessel is impeded by the towing of barges or other craft, for a distance of more than five hundred miles, without previous and seasonable notice being given to passengers, in all such cases the passage money shall be refunded, and all damages sustained by such default or delay shall also be paid.

SECTION 11.—For intentionally obstructing or deranging the means of regulating or indicating the pressure steam, two hundred dollars fine, and imprisonment not exceeding eighteen months.

SECTION 12.—That if at any time the water in the boiler be suffered to fall below three inches above the flue, if it be by the order, assent, or connivance of the master, he shall be fined one hundred dollars; and if an explosion or collapse happens in consequence of such deficiency, he may be further punished by imprisonment, for a period of not less than six nor more than eighteen months.

SECTION 16.—For using, or causing to be used, any boiler, or steam-pipe connecting the boilers, made (after the 1st day of July, 1853) of iron not stamped according to law, five hundred dollars forfeit.

SECTION 25.—One copy of all certificates of inspections required by this act (including those for carrying gunpowder, &c.), to be kept at all times, in some conspicuous place in the vessel, where most likely to be observed by passengers, in default of which, a fine of one hundred dollars is imposed.

SECTION 27.—All equipments of boats must be kept at all times in conformity to the inspectors' certificate. In default of which, the master is liable to a fine of one hundred dollars, or imprisonment not exceeding two months, or both.

SECTION 28.—That on any such steamer navigating rivers only, where from darkness, fog, or other cause,

TABLE I.

Statement showing the number of *Steam* Ships lost or damaged on the Coasts of the United Kingdom, and the number of Lives lost in consequence; also the number of *Vessels* of every description lost or damaged by collision or otherwise on the Coast, and the number of Lives lost in consequence; from 1851 to 1864 (inclusive).

	STEAM SHIPS.						TOTAL—SHIPS.	
					TOTAL.			
Year.	Lost.	Lives lost.	Damaged.	Lives lost.	Casualties to Steam Ships.	Lives lost in Steam Ships.	Number of Vessels of every description lost or damaged.	Number of Lives lost.
1851	9	1	40	..	49	1	1,425	293
1852	9	16	12	1	21	17	1,072	920
1853	10	173	17	2	27	175	905	689
1854	16	520	31	..	47	520	1,081	*1,549
1855	14	43	57	..	71	43	1,388	469
1856	12	1	90	10	102	11	1,469	521
1857	13	44	101	1	114	45	1,420	532
1858	23	53	99	1	122	54	1 471	340
1859	19	487	81	6	100	493	1,769	†1,647
1860	11	72	78	12	89	84	1,677	537
1861	11	75	76	1	87	76	1,819	884
1862	16	113	101	6	117	119	2,827	690
1863	12	33	74	2	86	34	2,001	620
1864	22	82	114	1	136	83	1,741	516
	197	1,713	971	43	1,168	1,756	21,065	10,207

* In this year the "City of Glasgow" and "Tayleur" were lost. † In this year the "Royal Charter" and "Pomona" were lost.
(NOTE.—The "John" was lost in 1855—191 lives lost.)

TABLE II.

List of Inquiries, held by direction of the Board of Trade, into the Loss of Vessels on the East Coast of Ireland in the years 1856 to 1865 inclusive.

Year.	Name of Ship.	Tonnage.	Where wrecked. Direction and force of wind.	Lives lost.	Report after inquiry.
1856	*Proteus*, of Sherborne, U.S.	273	Blackwater Bank Wind S.S.W.—9	2	A foreign ship. No inquiry held. Vessel lost through neglect of the lead.
1857	*Emperor*, of Liverpool, from Liverpool for Bahia	368	Blackwater Bank S.S.E.—6	nil	Neglect of lead. Master's certificate suspended for six months.
,,	*Lady Ebrington*, of Liverpool, from Liverpool for Valparaiso	413	Blackwater Bank S.S.E.—5	nil	Master reprimanded and cautioned as to use of lead for future.
1858	*Sir Charles Napier*, of London, from Liverpool for Sierra Leone	620	Kish Bank..... S.S.E.—6	1	Improper stowage. Compass affected by cargo. Master reprimanded.
,,	*Rose* (steam ship), of Glasgow, from Morecambe Bay for Belfast	344	Bush Rock, west point of Copeland Island.... W.N.W.—4	nil	Neglect of lead. Master admonished.
,,	*Amazon*, of Liverpool, from Liverpool for Pera.....	237	Arklow Bank.... S.W. by S.—5	nil	Neglect of lead. Master's certificate suspended for six months.
1859	*Pomona*, of New York, from Liverpool for New York	1,500	Blackwater Bank E.S.E.—9	424	Neglect of lead. Master drowned.
,,	*Clymene*, of Workington, from Liverpool for ——	745	Kish Bank..... Unknown	nil	Neglect of lead. Master admonished.
1860	*Calcutta*, of London, from Liverpool for Madras	527	Arklow Bank.... S.S.W.—4	nil	Neglect of lead. Certificates of master and mate suspended for six months.
,,	*Lydia*, of Liverpool, from Liverpool for Monte Video	433	At Ballinamona, inside the Blackwater Bank ... E.—11	3	Unable to weather the bank, and was run ashore. Master's certificate suspended for six months.
1861*	..	..	..	..	
1862	*Adonis* (steam ship), of Waterford, from Belfast for Waterford..	334	Muglin Rock, near Dalkey Island, Dublin Bay .. N.N.W.—6	nil	Vessel lost by neglect of master. His certificate of service cancelled.
,,	*China*, of Windsor, N.S. from Liverpool for Halifax	830	Kish Bank ..... Variable.—4	nil	Neglect of lead. Master's certificate of service cancelled.
,,	*Dalemain*, of Liverpool, from Liverpool for L'Union, Central America	275	Arklow Bank.... S.W.—8	nil	Neglect of lead. Master's certificate suspended for three months.
,,	*Eliza Bencke*, of Liverpool, from Liverpool for Bombay	983	Glasgorman Bank, Co. Wexford .. S.E.—6	nil	Neglect of chart and bearings of lights. Master's certificate suspended for three months.
,,	*Portia*, of Liverpool, from Liverpool for Pernambuco	298	Lucifer Bank, Co. Wexford..... S.E. by S.—7	9	Neglect of lead. Master acquitted. [The Board of Trade did not agree with finding of Court, considering that the master should have provided himself with a recent chart of the channel, and have used the lead.]
1863	*Sarah Palmer*, of Liverpool, from Calcutta for Liverpool	1,301	One mile S.S.W. of Tuskar Rock N.N.E.—8	nil	Neglect to take bearings. Master's certificate suspended for six months.
1864	*Desert Flower*, of Liverpool, from Liverpool for Calcutta	1,216	Long Bank, Co. Wexford..... S.E.—4	2	Neglect of lead. Master's certificate suspended for twelve months.
,,	*Euroclydon*, of Liverpool, from Quebec for Liverpool.....	1,325	Tuskar Rock .... W.—2	nil	Careless navigation. Master's certificate suspended for six months.
,,	*Florist*, of Liverpool, from Liverpool for Nassau	264	Long Bank, Co. Wexford..... S.S.E.—8	nil	Neglect of lead. Master's certificate suspended for six months.
,,	*Grassmere*, of Liverpool, from Greenock for New Zealand	432	Ballyferis Point.. N.—5	nil	Careless navigation. Master's certificate suspended for six months.

* No casualty.

TABLE II.—(*Continued.*)

Year.	Name of Ship.	Tonnage.	Where wrecked. Direction and force of wind.	Lives lost.	Report after inquiry.
1865	*Savoir Faire*, of Liverpool, from Liverpool for Calcutta	1,395	Blackwater Bank N.N.E.—5	nil	Neglect of lead, &c. Master's certificate suspended for nine months.
1865	*Ocean Ranger*, of Liverpool, from Liverpool for Savannah	456	Malahide Bank .. S.S.E.—7	nil	Neglect of lead and careless navigation. Master's certificates suspended for twelve months.
,,	*Barbadian*, of Liverpool, from Liverpool for Barbadoes	724	Blackwater Bank S.W.—9	19	Neglect of lead and careless navigation. Master drowned.
,,	*Lady Hobert*, of Liverpool, from Liverpool for Bermuda	781	Malahide..... S. to S.S.W.—10	nil	Bad navigation. Master's certificate suspended for six months.

TOTALS.

Ships.....	24
Tonnage	16,074
Lives lost.....	460

the pilot on watch deems the navigation of the vessel unsafe, or the engineer on watch shall be of opinion that the further navigation of the vessel is unsafe, and after being so admonished, the master then proceeds on his voyage without heeding such admonitions, he and the owners shall be liable for all damage to passengers resulting from such pursuance.

SECTION 29.—For neglecting or refusing to observe pilot rules, the master shall be liable to a penalty of thirty dollars, and all damage done to passengers resulting therefrom.

SECTION 30.—The master and owners are liable for all damage sustained by any passenger from explosion, fire, collision, or other cause, if it happen through any neglect to comply with the law.

SECTION 35.—A correct list of all passengers to be kept on record, and at all times open to the inspection of the inspectors and officers of the Customs, and in default the master shall forfeit one hundred dollars.

SECTION 36.—Two copies of the law to be kept on all steamers, and if he should unreasonably refuse to exhibit a copy to any passenger, the commander shall forfeit twenty dollars.

The Act of Congress of March 3rd, 1843, requires extra steering apparatus, in case the pilot is driven from the wheel by fire.

Treasury Department, June 10, 1864.

The following extract of Act of Congress, approved June 8, 1864, is published for the information and government of the officers of the Customs, supervising and local inspectors of steamboats, and others concerned.

S. P. CHASE, *Secretary of the Treasury.*

SECTION 3.—And be it further enacted, That each engineer and pilot licensed according to the provisions of said act, shall pay for every certificate granted by any inspector or inspectors the sum of ten dollars, to be accounted for in the mode provided by law.

SECTION 4.—And be it further enacted, That the forty-second section of the Act of August 30, 1852, be so construed as to require the inspection of the hull and boiler, in the manner prescribed by that Act, of every vessel propelled in whole or in part by steam, and engaged as a ferry-boat, tug, or towing-boat, or canal boat, in all cases where, under the laws of the United States, such vessels may be engaged in commerce with foreign nations, or among the several States.

SECTION 5.—And be it further enacted, That all engineers and pilots of ferry boats, tug boats, towing boats, or canal boats, subject to inspection by this Act, shall be classified and licensed in the same manner as are pilots and engineers by said Act of August thirty, eighteen hundred and fifty-two.

SECTION 6.—And be it further enacted, That in lieu of the fees for inspection required by the thirty-first section of the Act of August thirty, eighteen hundred and fifty-two, the following shall be paid:—For each vessel of one hundred tons, or under, twenty-five dollars, and in addition thereto for each one hundred tons, over the first one hundred tons, five dollars.

SECTION 7.—And be it further enacted, That all parts of the Act aforesaid, which are suspended by, or are inconsistent with, this Act, are hereby repealed.

Approved June 8, 1864.

DISCUSSION.

Mr. FREDERICK WOOD said, notwithstanding the arguments brought forward in the able paper they had just heard, he was of opinion that although all matters of detail should be left as much as possible to the shipbuilder, it was the duty of Government to step in and see that no precautions were omitted for the security of life and property. He thought the author of the paper had dealt a little unfairly towards the Government in mentioning gross acts of negligence on the part of masters, and apparently expecting the Government to be responsible for them. It was argued that the value of a vessel and cargo were sufficient inducements to cause a shipowner to study her safety before every other consideration. He denied that that was the case. In the first place, the vessel could be insured; the cargo for the most part belonged to other persons, and that could also be insured; while the passengers' fares were paid. It became a mere calculation of probabilities for a shipowner to send a vessel to sea over-laden and with the neglect of ordinary precautions, because it was extremely unlikely during many months of the year that a ship leaving these shores would encounter a hurricane within the first fortnight of her departure, and after that she would be in better trim to meet it. He could not agree that optional was better than compulsory inspection—the former was in fact of little value. He thought the author of the paper was a disciple of that great leader of modern political heresy, the author of the essay on "Liberty." Was it a truism that shipowners would always have vessels constructed in the best possible manner? And was it equally a truism that the best provision was made for the preservation of life, without any regard to the profits to be made by the voyage? He had listened in vain for any allusion to the crews of ships. Few persons would dispute that the crew formed a not unimportant part of a ship's equipment, and yet a vessel might leave our ports without a single seaman on board, and the Government had no power to interfere, for so long as the commander of the vessel and his officers were certificated by the

Board of Trade, it was sufficient! A great proportion of the losses at sea were owing to the miserably insufficient crews which were sent out. There was another point of great importance, which produced more evil results than any interference on the part of the Government could do. It was no longer compulsory upon shipowners to carry apprentices, and it was well known that the race of the British sailor was thus rapidly becoming extinct. Vessels were now manned with the most heterogeneous mixture of people—Swedes, Norwegians, Danes, and men from all parts of the world, some of whom were even engaged through the medium of an interpreter — men who did not know "port" from "starboard" in English, and every one must know the extreme danger of such a state of things when prompt measures were required to avoid a collision at sea.

Mr. SAMUDA said, whilst there was a great deal to admire in Mr. Gray's paper, there was very much with which he did not altogether coincide. He thought there was no doubt that Government supervision was, to some extent, desirable, though, if carried too far, it would be injurious. The view he took was that competition and the influence of public approval were the surest incitements to a professional man to induce him to do his best. He thought one great evil in the present day was the love of cheapness which had grown upon the public, and exercised an unfortunate influence in the trade to which he belonged. It thus became very difficult for a man who strictly desired to produce the best ships to do so, when he was liable to be undersold by less conscientious builders. It was only a long career of success that would make a man independent of such competition. It appeared to him, however, that if the public were not by this means alone getting that amount of good material and good workmanship which they really required, then it was only right that the Government should come forward for the protection of the public in a matter of such vital moment. Take the instance of a passenger ship carrying out a large number of emigrants. Those were a class of people, generally speaking, practically incapable of obtaining justice for themselves. A certain amount of air-space and accommodation was necessary for them, and certain general rules had been laid down for their benefit; but this was not all that was required for their safety; the proper means of escape in case of accident ought also to be provided; and here the interference of Government might be valuable in the regulation of the number of boats. This should be according to the number of passengers, and not, as at present, merely according to the tonnage. He believed that legislation upon great principles would be useful; but when it descended to details, it became positively vicious. He could not help thinking that on the whole, as far as steam navigation was concerned, some advantages had arisen to the public from Government inspection. So long as Government confined itself to inspection ship-builders had a strong incentive to go on improving; and they had the opportunity of giving proper development to their own ideas. Therefore he did not think it right to pass a sweeping condemnation upon the whole system of Government supervision and inspection; certainly not when it was confined within reasonable limits.

Mr. WM. HAWES said this subject, brought forward so ably by the gentleman who had read the paper, was only another form of that question which had been recently discussed in that place, as to the alleged benefits to be derived from Government interference, which, in fact, amounted to the transfer of responsibility from the individual to the Government. For his own part, he thought it was better for the public to be satisfied to rely upon the character of the shipbuilder or owner for the excellence of his vessels, rather than upon the responsibility of a gentleman appointed by the Government to inspect them, because it was impossible to suppose that such a person, appointed to those duties some years since, and who had been long in the office, would be so well up in the scientific improvement and progress in shipbuilding as those gentlemen whose whole prosperity depended upon turning out the most perfect form of ship that could be produced. If legislation could successfully be applied in any matter of general industry or commerce, shipbuilding was one in which the public would be naturally inclined to seek for its aid. The sympathies of all were involved in the question, for almost every one throughout this country had friends or relations occasionally trusting themselves to the safety of our ships. But the question was not whether every possible precaution ought or ought not to be taken. The question was whether those precautions would be taken more securely for the public interest by Government officers than by private individuals. Government inspectors were not always appointed for their special fitness, but frequently from political pressure or private friendship. Moreover, such officers might be fit men when they were appointed, but he contended that no man, however fit he might be at the time of his appointment, would be a match for the intelligence and ingenuity of the manufacturer ten or fifteen years after that appointment. It was, in fact, putting the inferior man to look after the superior man, and such an arrangement could not be practically useful to the public. They had been told by the first speaker that the gentleman who had read this paper was a disciple of Mill. He hoped he was, and that there were many others of the same school in that room, because Mill taught them the true principles of liberty, and independence of Government interference. The same gentleman argued that shipowners might be relieved of all anxiety as to pecuniary loss, because they would insure both ships and cargo. But was that the right way in which to consider this question? Would a captain of a ship really go to sea believing that it was to go to the bottom? Was not his life as valuable as those of the passengers he carried? There was no doubt that the captain, officers, and crew were generally anxious to do their duty, and, if possible, to carry the vessel across the sea in safety. But accidents would happen; and then came the question whether accidents happened more frequently in ships which had been built entirely under private surveillance or under the surveillance of the officers of the Board of Trade? The paper went to show that more accidents happened to vessels that had been inspected than to those that had not. The fact was that no person surveying a ship could form an adequate idea of it unless he had seen it built. When the machinery was once on board and fitted in its place, how could the surveyor tell whether the boilers were efficient or not? The public must rely upon the known strength or goodness of the work of the manufacturer, and not upon the inspector's examination. Some years ago, he (Mr. Hawes) was interested in a company which proposed to establish steam communication between this country and Australia, but its operations were very greatly impeded by these surveyors. They did not believe that an iron ship—especially if propelled by a screw—could go to Australia; and it was only with very great difficulty that those ships passed the Board of Trade surveyor. But what would have been the result upon the industry of this country if they had not done so? A great amount of our industry would have been checked, and commercial progres materially impeded. It was absurd to suppose that the improvements of individuals or of manufacturing firms were to be held in check by the preconceived opinions of Government surveyors. He knew there were important cases in which apparently strong claims for Government superintendence were made out, but this was merely because everything connected with the sea enlisted the sympathies of all, and induced many to forget the true principles on which commercial success depended. Government inspection transferred the responsibility from the shipbuilders and shipowners to the Government, and when any negligence arose they screened themselves under

the plea that they had conformed to the Government regulations. It was seldom that official inquiries resulted in satisfactory verdicts. They were almost always one-sided and partial. It might be that the Government regulations had been complied with, but it often happened that a ship was lost from some accident not contemplated by the Government regulations at all, and the official investigation ended in nothing, or at most, in the suspension of the master's certificate, and what punishment was that to the owners of the ship? Let them, in such cases, appeal to the remedy at common law, and where it was proved that owners sent ships to sea in an improper state, let them pay the penalty. There would then be the best possible security that good ships would be sent to sea, which would not be the case so long as we relied upon Government interference, and thus relieved the owners of that responsibility which, by every principle of law and equity, they ought to bear.

Mr. Edwin Chadwick, C.B., remarked that for once he agreed, to a considerable extent, with the views enunciated by his friend who had just sat down. If it became a question between the responsibility of self interest on the one hand, and on the other the responsibility induced merely by regulations, he would prefer to trust himself to the former. He would adhere to the responsibility of self interest, but that interest must be a real, solid, close, and pinching interest. Mr. Chadwick proceeded to illustrate his views by reference to the convict transport system, in which, in the first instance, a capitation payment was made on embarkation, and this resulted in the loss of half the convicts put on board; by degrees that loss was reduced to one-third; but when, under the auspices of a new colonial administration, the system was altered to a capitation payment for all the convicts that were landed at their destination, the contrast was very striking indeed, and the owners of the vessels carried surgeons, and the best means were devised for landing the largest possible number at the port for which they were bound. The same results applied, to a very great extent, to pauper emigration. He went on to state that he would not on any account remove this responsibility from the owners of vessels. Official inspection of ships, as to material, construction, and machinery, must necessarily be of a very superficial character. It was impossible to go into minute details, but there were cases in which supplemental provisions would come in aid of the principle of the mere responsibility of self-interest. Comparing the Royal Navy with the mercantile marine, it would be found that the casualties were just about one eighth less in the former than in the latter. He thought a regulation that every ship should carry a sufficient number of life-boats to convey those on board in case of accident (without insisting on any special type of boat), would not be objected to by the shipping interest. On the subject of insurance a good deal might be said. He thought to a certain extent it had tended to impair the whole character of our mercantile marine. As long as a ship was insured the owner became careless what sort of crew he put on board, and what sort of ship he fitted out. It was the fact, however, that a large number of ships were sent out uninsured, and there was no doubt that such ships were very much better manned than those which were covered by insurance.

Mr. Clifford Wigram said, as a large ship builder and owner, he had probably seen more of the working of the Acts of Parliament, alluded to in the paper, than most persons present, and his own experience had been that they had not operated prejudicially to the interests of such shipowners as were fully desirous of doing their duty. Speaking for his own firm, he would say they had never been requested to add a single precaution to any of their ships; they had always anticipated every demand of the kind. He could not but think, however, that the valuable part of Government superintendence was the protection it afforded to an honest shipowner, desirous of doing his duty, but who, perhaps, did not himself know a great deal about ship building, and was obliged to trust very much to the builder whom he employed to build him a first-class ship at the lowest tender. A first-class ship was a very indefinite thing; and he thought that Government inspection, which stepped in for the protection of life, was very valuable to the owner who was anxious to do his duty to the passengers he carried. He had been struck with the fact that nearly the whole of the discussion had been upon iron ships. They had heard a good deal about bulkheads, which could not be placed in wooden ships.

Mr. Gray said several of the wooden ships of the City of Dublin Company were fitted with bulkheads, and Mr. Samuda remarked that this was not an unusual thing.

Mr. Wigram would say he had never seen bulkheads fitted watertight in wooden ships; besides, they involved points of weakness in other respects. The stringent points in Government inspection were those which related to the safety of life; the goods might very well be left to the owners to protect, but when life was concerned it was a different matter, and he did not think the requirements of the Government surveyors were such that any shipowner ought to object to them. Something had been said upon the question of cables and anchors. If an owner was desirous of having a good cable, and paid a fair price to a first-rate manufacturer, he was pretty sure to have a good article; but if he contracted for a cable at a low price he must expect to get an inferior one, and the underwriters might be the sufferers in the end. On the question of underwriting it had been said that when a ship was sent to sea fully insured, the tendency was to make the owner indifferent to the result. He thought that was a false view of the case. All large shipowners knew that if they owned ten or twelve ships the cheapest thing was not to insure at all. In his own firm the premiums on their ships would amount to between £4,000 and £5,000 a-year, and as, until the late loss of the *London*, they had not lost a ship since the year 1809, it might be calculated whether it was worth while to insure their ships, or to send them to sea so equipped as to enable them to escape as far as possible the risks which large owners were content to take upon themselves.

Mr. Farrer, as having had a good deal to do with the carrying out of the Act of Parliament referred to, was anxious to know what was meant by the suggestion of Mr. Samuda, that the Government regulations should be confined to principles and should not extend to details. Did that mean that the Board of Trade were to have an arbitrary power to say what should be done? Were they to send an officer to say, "You shall have such compasses, such boilers, and such safety-valves?" He would say, for his own part, he decidedly objected to taking any share in the regulation of such matters.

Mr. Samuda explained that what he said was the reverse of that. He would not have interference with details; but if a ship was found to be unseaworthy she must not be allowed to go to sea.

Mr. Farrer did not see how a proper inspection could be made without going into details. Mr. Wigram had said a good shipowner did even more than the Government required. He was aware of that fact, and that formed one of his objections to this sort of legislation. Legislative rules on this subject must always be of the *minimum*, and not of the *maximum*, and the evil was that a legislative *minimum* had always a tendency to become practically a *maximum*. Then, again, it had been sometimes argued that it was desirable that one shipowner should be protected against others of a less honourable character. That would involve a protection to the good article in the shape of a Government brand of excellence. Such a thing had been proposed, but it appeared to him to be founded upon a wrong principle. After all they must look to self interest, and not to Government regulations, as the great element of the safety of life on board ship. The point he would press upon the meeting was that there were two principles and

two ways in which they could act for this object; one was to leave the shipowner, the builder, and the engineer free to choose their own means, and make them responsible for the ends; or else they might dictate the means, and then they must relieve those parties from the responsibility of the ends. They could not oblige a shipowner to put in such a number of bulkheads, or such a kind of safety valve, and then, if the ship was lost, blame him for not making proper provisions for her safety. The principle of common law was to make the builder responsible to the owner, and the owner responsible to the passengers whom he carried. It must also be borne in mind that if an owner sent an unsafe ship to sea he could not recover on his policy of insurance. But this principle was inconsistent with those rags and tatters of protection with which we had been clothing the giant of British industry for years. We must adopt one course or the other—either on the one hand appoint a numerous staff of surveyors, and thus relieve the shipowner of the responsibility, or we must say, "choose your own means, but we require you to produce a safe and proper ship." On this subject no less an authority than Mr. Anderson had stated before Mr. Lindsay's committee that he wished the Government to appoint such persons as they thought proper to examine ships, and to give certificates; but after that the owner should be free from all liability. That would be a legitimate consequence, although he thought Mr. Anderson was wrong in that recommendation. With regard to what had fallen from Mr. Hawes as to the character of official inquiries into the causes of the loss of vessels, he (Mr. Farrer) thought it was a proper function of the Government to throw all the light possible upon the causes of an accident, let the consequences to the owner be what they might. Mr. Hawes argued that these inquiries were followed by no result, but he (Mr. Farrer) did not find it so when ship-owners were before the Board of Trade. They had no objection to statutory regulations, but when it came to inquiries which rendered them liable to penalties and damages they did not much like such inquiries. Whenever a great casualty occurred at sea, an outcry was raised that something must be done, but he thought one of the two principles must be adopted, either the shipowner or the Government must be made liable; they could not take an intermediate course.

Mr. HENRY MAUDSLAY said there were cases in which Government inspection was desirable. An engine manufacturer might send out from his works engines of the best description and efficient in every respect, but they would not always last so. They might get into hands in which they would soon be destroyed, and in such cases Government inspection would properly come into play. A vessel also might be constructed upon the best known principles of the period at which it was built, but it might not continue so good. Anchors and chain cables might be furnished by the best makers and the highest prices paid for them, but extreme strains might be brought upon them, and a frosty day might affect the cable to such an extent that it would break under a strain that it would have borne in the summer time. After a cable had been subjected to extraordinary strains in heavy gales it ought to be proved again. It was the same with vessels, which required periodical inspection. Having pointed out the desirability of periodical inspections of engines, Mr. Maudslay remarked that, notwithstandiag the presumed vigilance of the inspections in America, surreptitious means were adopted to evade the statutory regulations; and he mentioned a case in which a weight had been attached to the bottom of a safety valve inside the boiler, so as to deceive the inspector. When a boiler was sent to France, the first act of the French Government Inspector was to drill a hole through it, in which he inserted a plug of metal, which would melt at a certain temperature; but that precaution was sometimes evaded by the engineer causing a little jet of water to squirt upon the plug, and prevent its heating to the point of melting. Upon the whole he thought that a certain amount of Government inspection was desirable and necessary.

Admiral Sir EDWARD BELCHER offered some remarks upon the period of the first introduction of water-tight compartments in vessels, stating that, in 1818, he laid that form of construction before the Admiralty, and it was carried out in the *Erebus* and *Terror* in 1835. About that time ships were fitted by the Admiralty with five transverse watertight compartments, with the addition of longitudinal bulkheads for security in case of collision. With regard to lifeboats, it was a misnomer to apply that term to the boats generally carried by ships; they doubtless had a certain amount of buoyancy, but they were not entitled to the appellation of lifeboats.

Mr. CAMPIN remarked that Mr. Hawes had alluded to the common law liability which attached to shipowners and others, but he had omitted to say who was to pay the costs which attended proceedings at common law, and in the case of poor emigrants, the means of carrying on a prosecution against a shipowner were very slender indeed.

Capt. JASPER SELWYN, R.N., having spoken upon points of construction, in reference to the wreck of the *London*, remarked that, upon the general question of responsibility, he might instance the action of the law with regard to drunkenness and other offences, where the means of detecting an offender was not by sending a policeman to watch how many glasses of liquor he had taken and then punishing him, but if it was proved that he was actually drunk, he was punished for being so, without inquiry into the cause. He thought the same principle might be applied to the present case. If the responsibility were placed upon the shipowner, and loss of life occurred from a wreck, the old principle of the English law was to inflict a penalty or "deodand," unless it could be shown that the disaster was occasioned by what was called "the act of God," or, in other words, was one that no precaution could provide against. In cases where three-fourths of the crew were foreigners, not even known to the captain of the ship, or when a ship had been overloaded and the ordinary precautions against danger had been disregarded, he would make the owner responsible. With reference to the statement in the paper as to the large number of wrecks that had taken place on a particular part of the coast, which in the majority of cases were attributed to neglect of the use of the lead, he would state that an eminent engineer and electrician had devised a plan by which the approach of a vessel into shoal water was indicated without the use of any lead whatever. If any definite principle could be laid down in reference to responsibility, he submitted it should be that which he had just enunciated, viz., that the owners and commanders of vessels—not their subordinates—should be held responsible. So long as the owners and commanders of ships felt this responsibility, their vessels were well managed; but the instant that responsibility was removed by Government interference, the evils so ably pointed out by the author of the paper were the inevitable result.

Mr. C. F. YOUNG entertained no doubt as to the desirability of some kind of superintendence and inspection. The first thing was to devise a proper mode of surveying ships, and the next was to see that it was properly carried out. In respect of the first point, Lloyd's committee had prepared elaborate tables and rules, and on the next it had been found, in the case of some Galway ships, on their arrival at the mouth of the Thames, that they wanted reconstructing, so that it was evident some improvement in the system was required. Self interest was very well, but there were the self interests of two parties to be considered, viz., that of the purchaser, who desired to get the article at the lowest price, and that of the seller, who endeavoured to get the largest amount of profit at that price, and the results of these clashing interests were in most instances most unsatisfactory to the public. He believed proper superintendence under well considered rules would be a great benefit.

Mr. WEBBER was in favour of the utmost possible amount of supervision on the part of the Government, especially in the case of large ship loads of poor emigrants. He related circumstances which had come under his personal knowledge in respect of the bad provisioning of those ships, the captain and steward having sheltered themselves under the plea that the whole of the meat had been inspected by a Government officer, who, however, had evidently not done his duty.

Mr. THOMAS GRAY, in reply, stated that he had listened to the discussion with attention and anxiety; at that late hour it would be impossible for him to review the pros and cons in detail; but he would say, on the general point, that with all his attention, and all his anxiety, he had failed to discover that any really sound and valid argument had been adduced in favour of statutory provisions respecting the construction and equipment of ships. Those who argued in favour of it appeared to him to argue in this defective manner:—Your ships and lives are lost, therefore statutory interference in constructive details is necessary. Whereas their argument ought to be, first, ships and lives are lost; secondly, statutory details would prevent these losses; and thirdly, therefore these details are necessary. That the interference would be beneficial must be proved before its necessity could be admitted; and his point was, that this benefit, the minor premiss in the perfect syllogism, had not been proved. Mr. Gray then reviewed the Emigration Acts, and contended that their real value did not consist in clauses requiring a ship to carry a chronometer and a compass, but in those clauses which gave the poor emigrant a speedy, safe, and expeditious remedy for damages. He then reviewed the American statutes, and contended from them that safety is not the handmaiden of supervision. He then referred to the *Garryowen* and the *Great Britain*, built without any supervision, and compared them with the celebrated Galway boats built when the system of Government nursing was at its height, and challenged the comparison in favour of unrestricted trade; he concluded by thanking those present for their patience and the kindness and impartiality of their criticisms.

The CHAIRMAN said he could not but express his deep regret at the absence of the right hon. gentleman (Mr. Lowe) who was to have presided on this occasion, for they would no doubt have had from him a brilliant speech, characterised by that wide information, power of logic, and weight of authority which he carried with him, whereas, from him (the Chairman) they could expect nothing of the kind. He further regretted Mr. Lowe's absence because, if he had been present, it would have afforded a spectacle which could be seen alone in this of all countries—that of an ex-member of the Government presiding at a meeting at which an officer of the Government was doing his best to bring into discredit the principle of governmental interference, and to show that in matters connected with the commerce and industry of the nation, the people of this country preferred to do without that Government interference, and in such matters felt themselves capable of governing themselves. He also felt that he owed the meeting some excuse for occupying the position he now did. He took an interest in this question, partly as an old sailor, or rather semi-sailor. In the second place as an officer of the Government, and as one who had been employed in a somewhat complex inquiry, in the course of which nothing had impressed itself so clearly upon his mind as the utter absurdity of Government pretending to regulate any branch of industry. Some few years ago he was a member of a Royal Commission of inquiry into the fisheries of the kingdom, and a more marvellous illustration of the blunders which the Government committed when it meddled with a branch of industry, could not be given than the results of those inquiries. He would mention only one or two instances. Our Government had entered into an agreement with the French authorities, after a great deal of discussion of the subject, that our trawling vessels should not carry a trawl beam more than a certain number of feet long. This was thought to be a wise regulation; but by great good luck nobody ever took notice of the Convention Act, and when the inquiry was made of the trawl owners what would have happened if the regulation had been obeyed, they replied that they would have been prevented from increasing the size of their vessels, which, in the progress of their trade, they had done to a considerable extent, for the trawl beam naturally had a relation to the size of the vessel. If this regulation had been carried out, it would, in fact, have crippled and paralyzed that particular branch of trade. A more curious instance still occurred on the coast of Scotland, and showed what might happen when Government "put its finger into the pie." There was a place where large quantities of herrings deposited their spawn, and the Government had forbidden the trawlers fishing at this spot, because there appeared to be a fear of their scraping up the spawn. When this was inquired into, however, and the fishermen were asked what induced them to go to that particular place, the reply was "Because we find an enormous quantity of flat fish there." They were asked, "What do these fish go there for?" The answer was, "To eat the spawn of the herrings;" and so this admirable Government regulation had led to the destruction of twenty times as much spawn as the trawls could possibly have injured. It was the strong impression which the whole course of that inquiry had engendered in his mind as to the injurious effect of every kind of Government interference with trade, which led him to attend this evening to hear what had been so well said by the author of this paper. There was another capacity in which he took an interest in this subject, viz., as a man of science, for though men of science were, perhaps, "wise in their generation," they were not always wise outside of it. He had observed of late that the Royal Society, of which he was a member, and which deserved in its sphere every respect and veneration, had, he thought, recently travelled somewhat out of its course in endeavouring to thrust upon the Government certain regulations on a nautical subject, by appealing to popular feeling. They had led the Government to enter into matters which involved questions as yet unsettled, either in the Royal Society or elsewhere, and in reference to which, even if settled, it was in the highest degree doubtful whether any Government regulation would be effectually carried out. He wished to enter his protest against the course taken by the Royal Society in this matter. Upon the general question which had been discussed he would merely say the whole subject resolved itself into a theory of government—whether the Government in this matter was to be a king or simply a system of police for punishing wrong-doers. From what he gathered in the discussion he came to the conclusion that it was the opinion of the majority of the speakers that the "police" theory was the right one. Some, it was true, thought they should like a little of the "king," but not much. He concluded by proposing a cordial vote of thanks to Mr. Gray for his paper, which having been carried,

Mr. GRAY briefly acknowledged the compliment.

Proceedings of Institutions.

LIVERPOOL INSTITUTE.—Mr. Charles Sharp, librarian and assistant-secretary of the Pharmaceutical Society, and co-editor of the *Year Book of Pharmacy*, has been elected secretary of the Liverpool Institute, and of Queen's College, Liverpool, in the room of Mr. Astrup Cariss, who has resigned this office, after having filled it for more than eleven years.

Fine Arts.

THE LOAN OF WORKS OF ART.—A bill has been printed and brought into the House of Lords, by Lord Stanley, of Alderley, providing that the owner for the time being of any work of art may, without incurring any responsibility for any consequent loss or injury, lend such work to the Lord President for the time being of her Majesty's Privy Council, for any period not exceeding twelve months, to be exhibited to the public by him or by his directions at the proposed exhibitions of national portraits, and the Universal Exhibition of Paris next year. The Lord President is to take due precautions for the preservation of all works of art lent to him in pursuance of this Act, but he is not to be personally liable for any loss or injury any article may sustain. The expression "owner for the time being" will include trustees of museums and other bodies of persons, whether corporate or unincorporate, having in their possession or under their control works of art, on trust for any public purpose, or for any artistic or scientific society, or possessed thereof on behalf of themselves and their successors; it will also include any tenant for life or other person entitled (otherwise than as mortgagee or as trustee for creditors) to the possession or enjoyment of works of art and science for life or any other limited period.

Obituary.

WILLIAM THOMAS BRANDE, D.C.L., F.R.S., the well-known chemist, died on the 11th inst. He was born in 1786, and was grandson of a physician who came from Hanover with George II., and was that king's physician. After an education at Westminster, he was sent to Hanover; but in 1803, on the panic of Napoleon's invasion, he returned home, and entered St. George's Hospital, attending the lectures and the dissecting-rooms, and communicating several papers to *Nicholson's Journal*, notably one on guiacum, which was read before the Royal Society. In 1808 he examined the calculi at the Hunterian Museum, and lectured on chemistry at Dr. Hooper's, in Cork-street. Then he became connected with the new medical school in Windmill-street, and embarked as a teacher and demonstrator of chemistry. In 1809 he became F.R.S., received the Copley medal in 1813, and from 1813 to 1826 was Dr. Wollaston's successor as senior secretary of the Royal Society. In 1812 he became a professor of chemistry and Materia Medica to the Apothecaries' Company, and in 1851 was elected master. In 1813, on Sir H. Davy's recommendation, he was appointed professor of chemistry at the Royal Institution, and delivered lectures for many years in connection with Faraday, who was also long associated with him as editor of the *Quarterly Journal of Science*. In 1825 he was appointed superintendent of the die department of the Mint; in 1836 Fellow, and in 1846 Examiner, of the London University. Besides Professor Brande's famous "Manual of Chemistry," which has been translated into many foreign languages, he was author of "Outlines of Geology," "Dictionary of Science and Art," &c. In 1853 he received the honorary degree of D.C.L. from Oxford University.

Notes.

THE SITE OF THE EXHIBITION OF 1862.—In the House of Commons, on Friday last, in reply to a question by Mr. C. Bentinck, as to what course the Government intended to pursue relative to the vacant ground in South Kensington and the erection of a building there; and whether any Bill was to be introduced this session for the removal of any of the collections now forming part of the British Museum, the Chancellor of the Exchequer said that the intention of the Government was to pass two votes for the disposal in part of the site acquired at South Kensington. One was for the erection of a building for the reception of the collections from the British Museum, and the other for a building for the reception of the collections of the Patent Museum. With respect to the introduction of a Bill this session for the removal of collections at the British Museum, that would not come on until they had disposed of the previous vote. But until they knew when they would be in a condition to obtain that, he would not be able to state the time when the Bill would be introduced.

Correspondence.

FREEHOLD LAND SOCIETIES.—SIR,—I have a perfect recollection of the interview with Mr. Beggs prior to the Social Science Congress. I gave him no figures verbally, but he had, I believe, our printed prospectus and reports, in which there are no traces of the general results of the meeting of the Conservative Land Society mentioned in the paper which he read to the Society of Arts. Mr. Beggs promised to send me the proof of the paper he proposed to read at the Sheffield Congress, and if he had done so, no such "singular inaccuracy" could have been made, as the one (I am willing to believe from some unaccountable misapprehension) he fell into—it appears at Sheffield as well as in London—which only met my eye after reading the report in your columns of the meeting at the Society of Arts. Mr. Beggs wishes your readers to infer, to account for the striking difference in the figures, that between the amount specified so erroneously there had been another report, that is, between August or September up to January, our receipts had amounted from £394,966 to £902,561 12s. 11d. This must have been assuredly an astounding progress, but the society cannot claim credit for such an imaginary issue of four months' operations. I am quite ready to acquit Mr. Beggs of an intentional misrepresentation, but I think, in his position as a director of the National Land Society, he ought to have been more careful in his statistics. I regret the inaccuracy the more, because, had I been present at the meeting of the Society of Arts, which I fully intended to have been, I should have been prepared to support, by some interesting statements, the main principle laid down in Mr. Beggs' paper, that in order to secure for the working classes healthy and cheap domiciles, no attempt should be made to pet and patronise, but that the intelligence and industry of the operative should have full play, that his thorough independence should be guaranteed, and that he should obtain his dwelling in healthy localities, at low rents, on his own freehold, by his own exertions, the mutual principle in the land or building societies being used in such a way that their commercial success in providing the sons of toil with houses, should be a guarantee to them that they were not dependent on eleemosynary aid.—I am, &c.,
CHARLES LEWIS GRUNEISEN, *Secretary to the Conservative Land Society.*
33, Norfolk-street, Strand, Feb. 11, 1866.

To Correspondents.

Letters from Sir Edward Belcher and Mr. Tarbotton have been received, but are not inserted this week for want of space.

MEETINGS FOR THE ENSUING WEEK.

MON.....Society of Arts, 8. Cantor Lecture. Mr. Fleeming Jenkin, F.R.S., "On Submarine Telegraphy." (Lecture V.)
R. Geographical, 8½. Mr. W. Chandless, "Exploration of the River Purus."
British Architect., 8.
Actuaries, 7. 1. Mr. W. P. Pattison, "On organization,

and its application to assurance companies." 2. Rev. Walter Mitchell, "On dual arithmetic."

TUES....Medical and Chirurgical, 8½.
Civil Engineers, 8. Mr. Edwin Clark, "The hydraulic lift graving dock."
Zoological 8½.
Ethnological, 8. 1. Sir John Lubbock, Bart., and Mr. Fredk. Lubbock, "On the true assignation of the bronze weapons, &c." 2. Mr. John Crawfurd, "On the origin and history of written languages."
Royal Inst., 3. Professor Frankland, F.R.S., "On the non-metallic elements."

WED.....Society of Arts, 8. Report by the Secretary, "On the results of the Art-Workmanship competition, from its commencement."

THURS...Royal, 8½.
Antiquaries, 8½.
Linnæan, 8. Mr. Herbert Spencer, "On circulation and the formation of wood in plants."
Chemical, 8. 1. Mr. C. R. Wright, "Chemical action of sunlight." 2. Prof. Church, "New Cornish minerals."
Royal Society Club, 6.
Artists and Amateurs, 8.
Royal Inst., 3. Professor Frankland, F.R.S., "On the non-metallic elements."

FRI..... ..Royal Inst., 8. Mr. G. Scharf, "On Portraiture."
Philological, 8.
Archæological Inst., 4.

SAT .....Royal Inst., 3. Rev. G. Henslow, "On systematic and structural botany."

PARLIAMENTARY REPORTS.

SESSIONAL PRINTED PAPERS.

Par. Numb. *Delivered on 10th February*, 1866.
3. Charitable Funds—Return.
5. Small Pox in Sheep—Order.
10. Public Debt—Account.

Delivered on 12th February, 1866.
1. Bills—Qualification for Offices Abolition.
2. ,, Railway Travelling (Ireland).
4. Cattle Plague—Copies of Nineteen Orders.
4-1. Ditto (Order 6th February, 1866).
7. Russian Dutch Loan—Account.
8. Sardinian Loan—Account.
9. Greek Loan—Account.
Cattle Plague—First Report of Commissioners.

Delivered on 13th February, 1866.
4. Bills—National Debt Reduction.
5. ,, Savings Banks and Post Office Savings Banks.
7. ,, Cattle Plague.
14. Australian Mail—Contract.

Delivered on 14th February, 1866.
6. Bill—Cattle Diseases.
6. Irish Reproductive Loan Fund—Account.
11. Mint—Account.
Cattle Plague—Second Report of Commissioners.
Russia—Report of Present State of Trade between Great Britain and.
Poor Relief (Scotland)—Twentieth Annual Report.

Delivered on 15th February, 1866.
8. Bills—Pensions.
16. ,, Juries in Criminal Cases.
1. Public Income and Expenditure—Account.

Patents.

From Commissioners of Patents' Journal, February 16th.

GRANTS OF PROVISIONAL PROTECTION.

Aniline green—3374—E. J. Hughes.
Arsenic—121—B. Todd.
Artificial flowers—242—W. Clark.
Asphalted felt—262—R. A. Brooman.
Augurs—32—W. E. Newton.
Bassinettes, stands for—292—E. R. Wethered.
Beds or mattresses for shipboard—120—H. F. Smith.
Blast engines—363—R. Gatley.
Boots and shoes—246—J. Piddington.
Buffers and draw and bearing springs—294—L. Sterne.
Buttons from plastic materials, making—244—L. D. Phillips.
Carriages, breaks for—277—G. de Witte.
China clay, &c., treatment of—200—C. G. Penney.
Coke—269—T. Drane.
Coke ovens—349—C. D. Abel.
Drapery goods, &c., measuring and blocking—325—W. Boase.
Dressing bags, travelling or fitted—329—H. Mitchell.
Electric clocks—136—A. V. Newton.
Engines for ascending steep inclines, locomotive—284—A. Chaplin.
Fabrics, covering the edges of—238—G. Hinchliffe.
Fabrics in bobbin net machinery, making—221—W. Hodgkinson.
Fabrics, washing, &c.—280—B. Farmer.
Fibrous materials, softening—268—W. Justice and E. Guild.
Floor cloths, printed—278—W. Hersee and G. Smyth.
Fur, &c., treating—264—A. V. Newton.
Gas meters - 274—W. W. Pocock.
Graving dock—190—W. E. Gedge.
Handwriting, sheets, &c., for improving the—170—J. Williams.
Horses' feet in frosty weather, portable appliances for—125—J. Harris.
Hydraulic steam hammer—312—H. A. Dufrené.
India rubber, &c., treating—300—W. R. Lake.
Lathes, &c., holding details for—337—W. Mackintosh.
Liquids, cooling—302—J. Miller and J. Pyle.
Liquids, distilling—70—J. M. Macrum.
Liquids, registering the flow of—375—J. Lewis.
Liquids, vessels for drawing off—315—E. Candler.
Mechanical valve respirator—339—W. Hibbert.
Metal, boring, &c.—3362—W. Harrison and T. Walker.
Motive power—181—W. Clark.
Motive power, obtaining—291—J. G. Tongue.
Oils, distilling and refining—319—J. B. Grant.
Ordnance and carriages—298—C. O. Staunton.
Pianofortes—248—H. Cooper, T. Dutfield, and A. Gibson.
Plugs—355—W. S. Cluderay.
Railway bars—260—W. H. Barlow.
Railway carriages, metallic cases for spiral springs for—229—J. W. Evans.
Railway carriages, wheels of—182—R. E. Kaulbach.
Railway engines, &c., vulcanized india-rubber springs for—168—G. Spencer.
Railway rolling stock, lubricating—365—T. J. Smith.
Railway trains, communication between the passengers, guards, and engine drivers of - 255—P. E. Waddell.
Red colouring matter or dye—341—J. Holliday.
Screw propeller - 17—H. Hirsch.
Sewing machines—331—G. Barker and C. Davis.
Ships, cleansing the bottoms of—252—H. Gardner.
Ships, securing the hatchways of—343—E. M. Leeds.
Stays or corsets—3238—W. Pretty.
Steam boilers—310—W. and J. Woodward.
Steam boilers—177—R. Clark.
Steer ng apparatus—321—A. Murray.
Spinning, mules for—335—J. and P. Warburton, and S. Barnes.
Sugar, refining—162—M. F. Anderson.
Textile fabrics, making and dyeing - 345 - F. B. Baker.
Torpedoes—379—C. A. McEvoy.
Trousers, &c., means of supporting—361—J. Jones.
Weavers' heads—282—W. R. Harris.
Weaving, looms for—250—J. A. Castree.
Weaving, looms for—323—J. J. and E. Harrison.
Weaving two cloths at one time, looms for - 3311—L. D'Aubréville.
Window fastenings - 254—D. Jones and J. Upton.
Windows, rack pulleys for roller blinds for—180—W. Parsons.
Wood, cutting holes or mortises in—377—A. Clark.
Wrought iron tubes—305—H. A. Bonneville.
Yarns, printing—210—J. Stringer and G. Birch.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

Liquid sewage to land, applying—431—J. Pilbrow.
Rudders, working—405—G. D. Davies.
Vices - 457 - W. R. Lake.

PATENTS SEALED.

2132. M. Cartwright and A. Dale.	2256. W. Clark.
2140. A. Watt.	2705. E. E. Middleton.
2173. J. Moody.	2856. J. Whitworth.
2198. E. D. Hodgson.	2869. W. E. Newton.
2199. R. G. Rattray.	3018. J. Whitworth.
2200. G. T. Bousfield.	3172. A. V. Newton.

From Commissioners of Patents' Journal, February 20th.

PATENTS SEALED.

2158. J. Lockwood.	2212. E. Davies & R. H. Taunton.
2162. D. O. Jones.	2232. T. Wrigley and M. B. Westhead.
2163. J. G. Avery.	
2164. G. Little.	2259. C. Horsley.
2167. J. Newton.	2260. J. Lake.
2168. L. J. Levisohn.	2298. A. Duvernois.
2169. D. Macpherson.	2303. A. Mackie and J. P. Jones.
2174. D. Davies.	2375. M. Henry.
2184. E. A. Curley.	2438. W. E. Newton.
2187. C. A. Watkins.	2454. A. V. Newton.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

12,466. T. C. Clarkson.	499. J. Clay.
393. G. Wrigley and S. Morris.	456. J. J. Badart.
412. J. Morgan.	505. W. Hooper.
417. W. C. McEntee, and G. and T. Withers.	738. J. Saunders and J. Piper.
388. J. Jones.	443. J. H. Bly.
485. W. H. Gauntlett.	448. G. T. Bousfield.
615. W. Whittle.	464. C. W. Siemens.
424. W. Nalder.	482. A. Dugdale.
	507. E. R. Walker.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

451. C. Garton.	446. T. Cattell.
528. G. Horner.	468. G. Paul.